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CONTENTS

	Page
Selection and Training for Research	941
An Essay on Morphogenesis. By Prof. C. W. Wardlaw	943
General Discussions on Chemistry. By Prof. J. R. Partington, M.B.E.	944
British Amateur Ornithologist's Vade-mecum. By R. M. Lockley	944
History of the North American Buffalo. By Dr. Maurice Burton	945
The Royal Society: Anniversary Address by Dr. E. D. Adrian, O.M., F.R.S.	946
Biology of Deserts. By Dr. J. L. Cloudesley-Thompson	951
News and Views	953
The Place of the Scientist in Civil Defence. By J. W. Martin, M.B.E.	957
The Alembic Club. By Prof. James Kendall, F.R.S.	959
International Council of Scientific Unions: General Assembly in Amsterdam	960
Seventeenth International Geographical Congress, Washington, D.C. By Prof. L. Dudley Stamp, C.B.E.	961
Instructional Film Research. By C. Denis Pegge	962
The Rockefeller Foundation: Report for 1950–51	963
United States Pulp and Paper Industries	965
Proximity of Genes controlling the Fermentation of Similar Carbohydrates in Saccharomyces. By Prof. Carl C. Lindegren and Gertrude Lindegren	965
A New Method for Acetylating Proteins. By Drs. J. Baddiley, R. A. Kekwick and E. M. Thain	968
Role of Sulphydryl Groups in the Oxidation of Pyruvate. By Dr. E. C. Slater	970
Letters to the Editors:	
Secrecy and Industrial Research.—Dr. C. E. Kenneth Mees, F.R.S.	972
N-Nitration and C-Nitration by the Nitronium Ion.—Eileen L. Blackall and Prof. E. D. Hughes, F.R.S.	972
Role of Water in the Structure of Psilomelane, $(Ba,H_2O)_2Mn_5O_{10}$.—A. D. Wadsley	973
Electronic Orbitals, Shapes and Spectra of Polyatomic Molecules.—Dr. A. D. Walsh	974
Electrical Conductivity of Cæsium Chloride near the Thermal Transition.—W. W. Harpur and Prof. A. R. Ubbelohde, F.R.S.	975
Paper Electromigration of Flavonoids and Sugars using a High Constant-voltage Current.—Dr. Yohei Hashimoto, Itsuhiko Mori and Mutsuo Kimura	975
Colorimetric Determination of Formaldehyde under Mild Conditions.—T. Nash	976
A Substance in Animal Tissues which stimulates Ketone-Body Excretion.—H. B. Stewart and Prof. F. G. Young, F.R.S.	976
Relation of 3-Hydroxykynurenine to the Ehrlich Diazo Reaction of Urine in Severe Tuberculosis.—Dr. Katashi Makino, Kiyoo Satoh, Tatsuo Fujiki and Kazuo Kawaguchi	977
Acetate Metabolism in Ovine Ketosis.—P. Storie Pugh and R. Scarisbrick	978
Relation between Total and Exchangeable Sodium in the Body.—Dr. R. E. Davies, H. L. Kornberg and Dr. G. M. Wilson	979
A New Type of Local Anæsthetic.—Emil Hofstetter	980
Sepsis and Cortisone.—Charles Cook and Charles Smith	980
Fibrinolytic Activity of Tissue Extracts and of Trypsin.—Dr. Tage Astrup and Ida Sterndorff	981
Migration and Gregarious Æstivation in the Bogong Moth, *Agrotis infusa*.—I. F. B. Common	981
Observations on the Newly Born Leopard Seal.—K. G. Brown	982
Terramycin in the Treatment of Experimental Rabies in Mice.—M. A. Haseeb	983
A New Early-Morning Ionospheric Phenomenon.—B. N. Bhargava	983
Automatic Particle-Sizing by Successive Countings.—P. G. W. Hawksley	984
Four-strand Crossing-over.—Dr. A. R. G. Owen; Dr. T. C. Carter and Dr. Alan Robertson	985
Computing Machine Terminology.—Dr. Andrew D. Booth	986

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SELECTION AND TRAINING FOR RESEARCH

SINCE in its report on "University Development from 1935 to 1947" the University Grants Committee commented on "the tendency to overemphasize in the name of research the value of certain forms of postgraduate activity which have little real importance from the point of view of advancing the frontiers of learning", the research activities of the universities of Great Britain have been frequently discussed, perhaps more especially in relation to higher technological education. In an interim report for the years 1947–51 issued early this year, the University Grants Committee reiterated the opinion that the universities must always remain the main agency for fundamental research, and from this view there is little, if any, dissent. The question at issue is rather the extent to which the ordinary science graduate should receive some training in research, and whether such training fits him or otherwise for an industrial career, which may or may not be in research.

It has been argued, though more particularly in respect of fundamental research, that only the exceptional man, who has given evidence of possessing the appropriate qualities of mind, should be encouraged to pursue postgraduate research in the university, and that such training is quite unnecessary for the ordinary student. If he has acquired a clear understanding of the scientific method and of the technique and fundamental principles of his chosen discipline, he should be able to adapt himself to whatever work may be required of him when he enters industry or on any other career. Moreover, the shortage of trained scientific men has made it essential that the methods of training, whether before or after entering industry or the selected occupation, should be as efficient as possible from the point of view of avoiding misfits and waste of trained man-power and of securing easy and smooth adaptation.

Such considerations make the proceedings of the second annual conference on industrial research held at Columbia University in June 1951* of wide interest in Great Britain as well as in the United States of America. The conference, which was sponsored by the Department of Industrial Engineering of that University, was concerned specifically with the selection, training and use of personnel in industrial research. To some extent it strayed into side-issues, as, for example, the discussion on operational research provoked by Mr. R. L. Ackoff's paper on methodology and mathematical statistics and their application in research, and by the papers of Dr. P. N. Powers on industrial research workers and defence, and R. M. Hogan on research and national man-power policy. The latter papers, however, demonstrated that the question of efficiency

* Selection, Training and Use of Personnel in Industrial Research: Proceedings of the Second Annual Conference on Industrial Research, June 1951. Sponsored by the Department of Industrial Engineering, Columbia University. David B. Hertz (editor), Albert H. Rubenstein (assistant editor). Pp. x+274. (New York: King's Crown Press; London: Oxford University Press, 1952.) 30*s.* net.

and avoidance of waste in training is as important in the United States as it is in Britain, and Mr. Ackoff's contribution emphasized the importance of the issue between generalized and specialized training in regard to the assimilation of the graduate in industry.

The two most critical issues raised in these discussions turn, first, on the specific qualities required in the industrial research worker, and second, on the recognition of these qualities and selection of the workers who possess them. The decision between general and specific training must depend, at least in part, on our ability to define fairly precisely the qualities for which we are looking, and to consider the methods which most effectively encourage the development of these qualities. Until that stage is achieved, there seems to be little point in fostering postgraduate research when the utility of the latter may be called in question from the point of view of subsequent adaptation of the graduate concerned.

In two of the papers, those of E. W. Engstrom, vice-president in charge of research in the Radio Corporation of America, and of Prof. D. B. Hertz, of Columbia University, much stress was laid upon the desirability of originality and creativeness. These are precisely the qualities that mark the outstandingly successful research worker, whether in industry or elsewhere, and at the same time they are those which are the most difficult to distinguish. Even as to the conditions in which they flourish and are best fostered we know relatively little, though those conditions are also the conditions in which research work in general is most fruitfully pursued, though not necessarily those in which high inventiveness is likewise encouraged.

Nothing in the discussion of these two papers suggested that, despite agreement as to the importance of creativeness, there is any recognized means of detecting it at an early stage; as Dr. Engstrom remarked, only experience can show whether a man possesses such powers. Apart from this, the main emphasis was laid on the soundness of the scientific training which a candidate for a research post in industry has received, and on his ability to work with others as a group. Whether he has already been engaged in research appears to be immaterial so long as he possesses these qualifications. It might be said that, as Dr. H. A. Leedy pointed out in a subsequent paper on training young research workers, the capacity to learn is more important than the knowledge the candidate has actually acquired, subject to a certain basic minimum.

It is comparatively easy to specify desirable qualifications for a research worker, as not only Dr. Leedy but also other conference speakers recognized, notably, besides Dr. Engstrom, Dr. H. K. Work in his paper on the university's role in training research workers. Besides fundamental professional knowledge already noted, and the ability to use it, much stress was laid by these three speakers on the personal qualities and character of the applicant, including not merely the ability to work with others, but also such qualities as the capacity to express himself clearly and concisely, his scientific inquisitiveness, practical outlook, initiative and energy. The difficulty is not to specify the desirable qualities but to determine which applicants possess them, and Dr. Leedy frankly admitted that the best we can hope for is that some few of the men chosen will live up to expectations.

Although it may be conceded that the quality of creativeness and imagination which lifts the research worker to the highest level is almost impossible to diagnose by any selection technique, Dr. Leedy's view as to the futility of selection techniques seems to be too pessimistic and scarcely warranted by the general trend of the discussions at this conference. At least if we know what we are looking for we should be able to eliminate a fair proportion of misfits, and even to do this involves avoiding waste of trained man-power on a scale sufficiently serious at present to justify an effort to improve existing techniques of selection. On this the Conference at Columbia University reflected opinion freely expressed at the Conference on Industry and the Universities organized by the Federation of British Industries in Great Britain in November 1949. Moreover, it brought out, as did the latter, that what industry looks for in its research workers is, in the first place, not so much training in the technique of research, or even the possession of creative ability and imagination. Industry is prepared to take a chance that the second will develop as training in the necessary research technique is given within industry itself. The prime necessity is the possession of a sound knowledge and understanding of some scientific discipline, and the ability to think clearly and to express ideas clearly in speech or writing. If a recruit possesses these qualities, together with those other personal qualities such as reliability and the capacity to co-operate, industry will be able to make effective use of him, even if he does not prove to be in the first rank as an original investigator. These qualities, moreover, are those which should be to a large extent the natural result of a university education, not only in the faculty of science but also in any other faculty. To the extent to which the university graduate seeking to enter industry is deficient in them, we should seek to inquire into the character of the education he received at his university and to remedy such deficiency at its source.

The corollary of an efficient selection technique for industrial research personnel is an appropriate standard in university and in technological education, and this is a point to be remembered in the current discussion on the expansion of higher technological education in Britain. There is, however, a further reason why industry can afford to take some chance in respect of creative ability on the part of its recruits for industrial research. Prof. S. B. Littauer, in his paper "What Makes a Good Research Man", pointed out, much as other speakers had done, that a research worker must possess a background of knowledge as well as some imagination and inventiveness, and that

the extent to which these are desirable is not easy to define. In technical research, however, logical procedures are dominant factors: such research demands the astute organization of reproducible knowledge pertinent to the problem under study, the focusing and weighing of evidence, the determination of the relevance of data and the unbiased testing of hypotheses. These and other requirements, such as making inferences from observations about the general principles which govern these observations and predicting from accepted principles what may be expected to result from selected operational procedures, amount to a methodology, the adequacy of which largely determines the effectiveness of the investigation.

Prof. Littauer argues that the research recruit should not be expected to possess such a scientific methodology, but that its acquisition should be encouraged by the research organization and the research director. What ultimately makes a good research man is a research organization and a research director that provide such encouragement, and with it the atmosphere, opportunity and stimulation to expand and utilize efficiently his substantive knowledge in an organized attack on the research problems confronting him. Not only will an organization which provides such conditions get the most effective results from its existing staff, but also it will not need to worry about selecting the creative and outstanding research worker. Such men will be attracted to work in the conditions which are most favourable to creative thought and work.

Thus we come back to the conclusions of the Barlow report on scientific staff. Selection techniques have their part to play in avoiding misfits, and especially if they have been used still earlier to avoid wasting time and money on those unfitted to profit by a university training; but they are of secondary importance compared with the provision of conditions in which creative work is most fruitfully pursued. If we do not offer these conditions, we shall not attract men of the quality we desire; and the warning is one that should be kept specially in mind at such a time of stringent economy, not least in government research establishments. But it is also relevant to the question of the form which new technological institutions in Britain are to take. Whether the technological research on an increased scale which is so desirable in Great Britain is developed within the walls of university departments of technology or of the higher colleges of technology or of a new technological institution, or in co-operation with industry or research associations in industry itself, matters relatively little, provided the conditions of academic freedom and status are provided which will ensure that the institution attracts to its staff men of the right ability and standing. If such conditions are satisfied and the right atmosphere exists, even sponsored research itself may present little difficulty and may indeed encourage the development, not merely of ability and technique in research, but also of the inventiveness and scientific curiosity which are so desirable.

AN ESSAY ON MORPHOGENESIS

Morphogenesis

An Essay on Development. By John Tyler Bonner. Pp. vii+296. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1952.) 32*s.* 6*d.* net.

THE subject of morphogenesis can be approached from many different points of view. In this very readable 'essay' Dr. Bonner has drawn widely on both the plant and animal kingdoms, especially the lower groups, to illustrate particular points. In general, his subject-matter will be familiar to those whose special interest lies in the study of morphogenesis; but he has dealt with many aspects in a new and refreshing manner. Thus he has contributed chapters on size and pattern, physics and chemistry of development, patterns of growth, patterns of morphogenetic movements, polarity and symmetry, patterns of differentiation, and an analysis of development. Botanists in particular will be interested to note to what good use he has put the developmental data of green algæ (Volvocales and Chlorococcales), myxomycetes and oomycetous fungi, in discussing morphogenetic movements which are so familiar to the zoologist. The author regards morphogenesis, or the emergence of an organismal pattern, as being referable essentially to the progressive, constructive processes of growth, morphogenetic movement and differentiation; and to the limiting of these processes in various ways by intrinsic and extrinsic factors which check, guide and canalize them. He also recognizes that the physical bases of many morphogenetic processes may or may not be the same for all organisms. Polarity, for example, has a different physical basis in different organisms.

In that even the simplest morphological or structural feature is the result of the action of a whole nexus of factors, and these of different kinds, it may well be doubted if any morphogenetic development will ever be adequately explained. Dr. Bonner, of course, makes no claim to having solved any of the problems of morphogenesis; but in a lucid and interesting manner he has discussed many of the major aspects and has shown, by reference to a wide range of examples of individual developments, that some phenomena are of very general occurrence and hence that it is reasonable to seek for common underlying causes.

The data of morphogenesis, already multitudinous, are increasing daily from diverse sources. There may, therefore, be several views as to how the subject is to be tackled in the hope of advancing knowledge. Few will disagree with the author that "the only way of finding a solution to the riddle of development will be to discover new and penetrating facts". As to how these facts are to be discovered it is, of course, hard to be explicit; but the thesis is advanced that a sustaining aim should be to search for a micro-theory which would explain in a satisfying manner the general phenomena of development; for such a theory is more likely to afford an insight into the inner mechanism of the relevant phenomena than any other kind of theory. The same general idea has also been advanced by other investigators, for example, Woodger. This matter is argued closely by the author, and, as he points out, such a micro-theory does not necessarily imply that all the phenomena of biology are to be brought down to physics and chemistry: some kind of intermediate micro-theory may prove quite satisfactory—for example, the action

of genes as envisaged in contemporary genic theory. No micro-theory can yet be offered; but the kind that would be satisfying would be one in which, as in crystal structure, the organism could be envisaged as being constructed of small repetitive units.

It is difficult, in a short review, to give an adequate idea of the contents of this volume, or essay, for it is essentially an extended discussion. The reader, however, may be assured that it not only touches on many of the main features of morphogenesis, as presently understood, but also that it is the product of much thought and bears the impress of a philosophic mind. C. W. Wardlaw

GENERAL DISCUSSIONS ON CHEMISTRY

Heterogeneous Catalysis

(Discussions of the Faraday Society, No. 8.) Pp. 366. (Aberdeen: Aberdeen University Press, Ltd., 1950.) 30*s*. net.

Colloques Internationaux du Centre National de la Recherche Scientifique

10: Réactions dans l'état solide, Paris, Octobre 1948. Pp. iv+222. 1100 francs; 25*s*. 30: Réarrangements moléculaires et inversion de Walden, Montpellier, 24–29 avril 1950. Pp. 152. 2000 francs; 44*s*. (Paris: Centre National de la Recherche Scientifique; London: H. K. Lewis and Co., Ltd., 1949–51.)

Institut International de Chimie Solvay

Huitième Conseil de Chimie tenu à l'Université de Bruxelles du 10 au 15 Septembre 1950. Le mécanisme de l'oxydation; Rapports et discussions. Pp. iii+503. (Bruxelles: R. Stoops, 1950.) 550 francs.

ALTHOUGH general discussions and symposia on selected topics are recognized features of scientific life, it is somewhat doubtful whether the publication of the proceedings contributes very much to the edification of the general reader. The papers presented are not often novel and generally consist of material already published, presented in such an abbreviated form that they are unintelligible except to specialists, and the discussion is usually chaotic and composed of fragments which are mutually self-destructive. The Faraday Society seems to have felt this situation, since its discussions are prefaced by summaries or surveys which try to make some sort of coherent picture of what occurred. It is no doubt true that the proceedings are stimulating to the participants; but the average scientific reader, in search of concrete information, may sometimes feel that, having fulfilled this purpose, they might well have ended there. A report prepared by an independent author is usually much more intelligible and informative.

The Faraday Society discussion on heterogeneous catalysis comes off rather well in these respects, since it includes some important new material in the experimental field, and although the subsequent discussions of the papers are on the familiar lines, they do not occupy too much valuable space. The introductory paper, by Prof. H. S. Taylor, is readable and informative. Some of the outstanding difficulties and contradictions in the field are dealt with in other papers. The section on techniques brings together some valuable information on modern methods. The whole volume is well above the usual standard of such discussions and cannot fail to be useful both to specialists and those whose interests are more general.

The two "Colloques Internationaux" are less praiseworthy. The articles are too numerous and too brief to be wholly intelligible, and the volumes leave a feeling of surfeit and mental dyspepsia which they are bound to produce in such a form. The topics are of great interest and importance; but the treatment as a whole does not present a coherent picture of the state of the subjects. All the same, the volumes will be found useful in a limited field. Readers who know little of the subjects will not know very much more after reading the fragments. It is suggested that a smaller number of contributions, more adequately treated and with some regard to the needs of non-specialists, would be more suitable. No doubt the participants gained much from the proceedings; but they might well have been satisfied with this and let the matter rest. May we hope that future publications will be more attractive to the general scientific reader?

The report of the eighth Solvay Congress contains some papers of reasonable length, carefully prepared and clearly presented. They are all intelligible and valuable, and a reader will gain real information from them. The field covered is wide, and includes the important biological aspects. The authors do not assume that the reader already knows what is in the papers, and in general lay the foundations well. The mathematical treatment is limited to what is really essential, and is adequately related to the experimental material. The discussions are often confused and unnecessary. The bibliographies are extensive and good. The subject of the mechanism of oxidation, in its present stage of development, is difficult and most important, and this volume may be said to clarify and unify a good deal of scattered material in a very satisfactory way. Some important newer reagents such as periodic acid have found extensive applications but are still not adequately treated in the detailed text-books. They are well represented here. The whole volume is sure of a welcome from many kinds of readers. J. R. Partington

BRITISH AMATEUR ORNITHOLOGIST'S VADE-MECUM

The Pocket Guide to British Birds

By R. S. R. Fitter. Pp. xvi+240+112 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1952.) 21*s*. net.

THIS text-book aims at presenting British birds accurately to the beginner by coupling Mr. R. A. Richardson's fine illustrations with the use, not of measurements and technical descriptions, but of a simple classification into eight groups: very short, short, medium short, medium, medium long, long, very long, and huge. There are also wing, neck, leg and bill ratios in similar categories. It seems a pity that the length of each bird is not given in inches, so that if the student finds himself very close to, or able to handle, a wild bird, he can check by measurement. To some extent the artist has overcome this difficulty by providing a silhouette of a sparrow upon each page of illustrations.

The beginner who may be at first confused by the novel classification in this book should take heart from Mr. Fitter's observation that even the expert cannot be confident about the identity of some of

the "small brown birds", unless they call or sing, when the novice possessed of a good ear may as quickly recognize the species; and he may turn to the key at the end of the book for alternative methods of identification—colour, structural features, behaviour, voice and habitat. There are a calendar of migration and breeding periods, lists of geographical races and rare visitors, and an index. About half a page is devoted to each common (or not very rare) British bird, and this section forms the bulk of the highly condensed but accurate text. The first to be described is the smallest, the goldcrest, classified under "Land Birds: Very Short". The last is the mute swan—under "Water Birds: Huge". Sensibly included are some introduced semi-feral species. Chinese goose, mandarin duck, 'London' pigeon and budgerigar, for example, are described; and they are likely to confuse the amateur in search of indigenous species, unless he is warned about these 'foreigners'.

This guide depends upon the success of Mr. Richardson's six hundred colour and four hundred black-and-white illustrations, of which Mr. Peter Scott, himself responsible for some free-flying non-indigenous wildfowl in Britain, says in the foreword that "nothing of the kind has been so well done in Britain before" and "a new bird painter of great skill has entered the field". I am inclined to agree that the combined efforts of artist and colour processor have been successful in overcoming the difficulties of presenting the fine differences of shade and tint between related species, to a degree not so uniformly attained before. The warblers have not been, and may never be, portrayed in colour to the satisfaction of the expert, so delicate and changeable are their tints, according to the strength of the natural light. It was a good plan to show alike-coloured, even though otherwise unrelated, species on the same page. The black-and-white illustrations are mainly of birds in flight, usefully showing wing-pattern and form. The whole seems to justify the claim on the jacket, of a pocket-guide which is also "the complete identification book".

R. M. Lockley

HISTORY OF THE NORTH AMERICAN BUFFALO

The North American Buffalo

A Critical Study of the Species in its Wild State By Frank Gilbert Roe. Pp. viii+957. (Toronto: University of Toronto Press; London: Oxford University Press, 1951.) 90*s*. net.

IT is unfortunate that our thirst for knowledge of the larger forms of wild-life often postdates their partial or complete elimination. Inevitably, perhaps, the pioneers of a spreading civilization have little interest in preserving, much less documenting, the natural features of the new worlds they open up. As a consequence, we are compelled to search diligently among the ruins for scraps of knowledge in order to build up even an inadequate story of what has been lost for ever. The story of the North American buffalo is but one of many, and in this book the author, after years of research, has written a thousand pages closely documenting the history of the buffalo, from its first discovery in 1530 to its virtual extermination in the 1880's.

Dr. F. G. Roe's text reads like a legal judgment, an objective recital of all the available evidence, with little sign of the possible verdict until, towards the end and preceding the four hundred pages of appendixes, bibliography and general index, he gives a few pages of concluding summary. The twenty-four chapters deal with the general characteristics of the buffalo, and with its habitat, but more especially with its former numbers, the regularity or otherwise of its behaviour, and its influence upon the Red Indians who occupied the same territory. Throughout, his approach is avowedly iconoclastic, and it is perhaps in a subconscious attempt to counteract this that his effort to maintain an objectivity leads to a certain obscurity in the writing.

It is the common practice in referring to the North American buffalo always to speak of their countless millions that blackened the plains. Dr. Roe seems to think that, even as a mere figure of speech, this is widely misleading, and he takes his reader through an analysis of a large quantity of reports and statistics to prove it. Yet there is more support for this contention in the evidence he brings forward to prove his second point, that the erratic habits of the buffalo accounted for the peculiar nomadism of the Indians of the plains.

Our modern information tends to suggest an almost clock-like regularity in the habits of wild animals, so that the idea of anything—bird, beast or even porpoise—wandering or behaving fancy-free is regarded as somewhat old-fashioned. In strong contrast to this, a case is made out in this book for believing that the behaviour of buffalo, singly or in herds, was strongly individualistic. The author goes so far as to reject any notion of vast seasonal migrations. His views are unorthodox, also, in regard to the habits of wolves. Observations in recent years on the North American wolf have suggested a remarkable regularity in its habits, but the evidence put forward by Dr. Roe leads him to suppose that the wolves formerly preying on the buffalo were compelled to an erratic nomadism in order to follow their supply of food. Moreover, he believes the Indians of the plains owed their nomadic habits to that same need for keeping in touch with their main source of subsistence, and he postulates a definite link between the presence of this inexhaustible supply of food and the Indian mentality and general outlook on life. Incidentally, he exonerates the Indians from the criticisms of wastefulness in their slaughter of the buffalo and fixes the blame very certainly on the improvident white settler.

Another conclusion given by Dr. Roe in his summary, especially interesting since he is an engineer by profession and not a biologist, is the more remarkable in that it is reached by way of a severely objective study of documentary evidence. To the many zoologists to-day who deny intelligence in any but the human species, with perhaps a dawning intelligence in the higher apes, Dr. Roe points out that, if the theory of evolution means anything, it must mean that "the dawning of the capacity for individual impulse *must begin somewhere*" (his italics), and he conceives "of no sound reasons why this should not apply to the buffalo species". Finally, "In relation to buffalo in particular, the most philosophic and generally reliable historian of the species at . . . large explicitly credits them with a degree of individual variation in conduct which can scarcely be ascribed to anything else than some form of personal intelligence, define it how we may".

Maurice Burton

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS BY Dr. E. D. ADRIAN, O.M., F.R.S.

AWARD OF MEDALS, 1952

Copley Medal

THE Copley Medal is awarded to Prof. Paul Adrien Maurice Dirac for his remarkable contributions to the quantum theory of elementary particles and electromagnetic fields. All his work has a very distinctive quality, in that he has known how to make evident the relationship of the remote abstractions of the pure mathematician to the extremely practical problems facing the atomic physicist. This appeared even in his earliest work, for in 1926 he took up the non-commutative algebra of Heisenberg, and solved the problem of a non-commutative planetary orbit. Not long afterwards, he showed how the 'matrix mechanics' of Heisenberg could be identified with the 'wave mechanics' of Schrödinger. It is this paper, with its development of the idea of 'representations of physical states', that more than any other has given the colour of his work.

The advances made in 1927 had not provided a relativistically invariant mechanics for the electron, nor had they explained the phenomenon of 'electron spin'. In 1928 he remedied both of these defects at the same time. Perhaps the deepest quality of this work was that it replaced the second-order equations, previously universal in wave-theory, by equations of the first order. These equations had some astonishing consequences, such as possible states of negative kinetic energy; and Dirac attempted a physical interpretation of these states by the concept of a background of electrons occupying nearly all such states. An unoccupied state appeared in the physical world to be a particle of electronic mass and positive charge, equal in magnitude to that of the electron. The 'positive electron' or 'positron' was actually only discovered several years later, and it fitted into Dirac's scheme.

During the same period he was responsible for another discovery of the very first importance, the Fermi–Dirac statistic which was independently formulated by both these authors. Dirac began with the conception that electrons are all identical, and made the point that unless electrons obeyed this statistic it would be possible to recognize their individuality; this is a typical example of the manner in which he has known how to devise the most practical conclusions from the most abstract principles. It was this statistic which served to explain the nature of the conduction of electricity in metals, one of the most formidable difficulties of the older physics.

Some of Dirac's most brilliant work was done at Cambridge while he was a Senior Student of the 1851 Exhibition. He was elected a Fellow of the Royal Society in 1930, the year in which appeared the first edition of his book, "Principles of Quantum Mechanics". This book has the highly individual character of all its author's work; considering the novelty and difficulty of the subject, its clarity of style and directness of approach are models of what a scientific text-book should be. Dirac was appointed to the Lucasian chair at Cambridge at the early age of thirty and was awarded a Nobel Prize in Physics, jointly with Schrödinger, in 1933.

Rumford Medal

The Rumford Medal is awarded to Prof. Fritz Zernike. In the year 1934 Prof. Zernike described a simple method of indicating the absolute errors in the surfaces of concave spherical mirrors. Realizing that minute defects in the regularity of the surface would give rise to diffraction images out of phase with the central image, he proposed the use of a phase plate to neutralize this difference. Interference then takes place, and on looking through the phase plate the position and magnitude of any irregularities are clearly indicated and may be retouched as necessary. A year later Zernike applied a similar method to the microscope, with results of far-reaching importance.

During the long period of the evolution of the microscope, there have been periods of quiescence and of great activity—the latter always stimulated by some outstanding individual. Of these periods it is only necessary to refer to the close of the past century when Abbe made what then appeared to be an exhaustive study of the light distribution in the back focal plane of the objective. He showed that objects with a highly organized structure gave rise to a series of diffraction spectra of the zero, first and higher orders.

It was then assumed that a transparent phase object must of necessity give rise to an image of low contrast unless suitable staining techniques could be employed to differentiate clearly between the various structures forming the object. The phase object was thereby converted into an amplitude object by means of elaborate techniques which gave rise to changes in the object and in some cases to artefacts. These methods could not, of course, be applied to living material.

By slightly modifying a standard microscope, Zernike showed that it was possible to neutralize the phase difference existing between the spectra of zero and first orders, and thus by interference to transmute the invisible changes of phase produced by the object into changes of amplitude in the resulting image. Living transparent cellular structures are by this means imaged in contrast in such a manner that for small phase changes the depth of tone at any image point is proportional to the phase change brought about at the corresponding object point.

To summarize, Zernike was the discoverer of a new and most valuable microscope technique, an advance comparable with that contributed by Ernst Abbe towards the close of last century. Phase-contrast microscopes are now in daily use in laboratories throughout the world. Science is also indebted to Zernike for many valuable contributions to the underlying mathematical theory. Zernike's work has also acted as a great stimulus to the study of diffraction phenomena and has led indirectly to other important advances in the field of interferometry.

Royal Medals

A Royal Medal is awarded to Prof. Christopher Kelk Ingold, professor of chemistry in the University

of London and director of the Chemical Laboratories at University College, for his extensive investigations of the mechanism of, and the factors influencing, organic reactions.

Over many years it has been Ingold's purpose to treat the mechanism of organic reactions in a quantitative fashion and to understand the factors influencing such reactions in terms of fundamental physical chemical concepts. Thus, for example, in the very early days he made the first successful attempt to understand the interaction between two ions, and between an ion and a permanent dipole, in terms of quantitative electrostatic factors, and applied this work to the velocity of the esterification and hydrolysis.

Ingold and his co-workers, for the first time, gave a complete elucidation of the reaction between an ion and a polar molecule. They have studied the influence of substituents on the velocity of organic reactions and have made the most detailed and beautiful analysis of the structure of benzene. All this work is characterized by detailed experimental investigation in which quantitative data on the mechanism of reaction have been obtained. On this quantitative work it was possible for Ingold to base a detailed theoretical framework, and it would be fair to say that no man has contributed with such detailed exactness and with such breadth of theoretical vision to our knowledge of the mechanism of organic reactions as has Ingold. Moreover, his work and ideas are not only applicable to the particular reactions which he has studied. His ideas are at the very basis of quantum chemical theory: in some cases he has anticipated quantum mechanical ideas —in others he has been quick to see the application of such ideas to his own work.

A ROYAL MEDAL is awarded to Sir Frederic Bartlett for his work on experimental psychology. The School which he founded at Cambridge on the beginnings made by Rivers and Myers became, under his leadership, the dominant school in Britain and one of the most famous and respected in the world. There were good reasons for this. Bartlett, at the beginning of his career, saw in mental process a field for experimental observation complete in itself, independent both of philosophical theories and physiologists' stimulus-response investigations. He very early recognized the many factors that enter into these responses and saw that they could be explored in manual and bodily action, in hand skills and skills at games, as well as in verbalizations. An interesting point was his discovery of the important part played by memory of previous performance in maintaining or increasing an individual's skill. His work has always shown great originality of method, unusual power of penetrating a problem and fertility in discovering analogous subjects for experiment. While realizing their validity in certain respects, he has shown a refreshingly critical judgment of the limitations of statistical methods in biology, and he has done much to prevent modern experimental psychology from degenerating into the composition of graphs and arithmetical tables.

His book on "Remembering" (1932) is a classic of psychological research, emphasizing the effects of social conventions and different ways of living on performance and response. During the Second World War, Bartlett and his pupils in the Cambridge laboratories did a great deal of research for the Services, especially on the effects of fatigue in diminishing quality of performance in pilots and the complex factors that facilitated it. Since then his advice has been eagerly sought in industrial personnel problems.

Bartlett's output has been considerable, but it is the clarity and conciseness of his thought which has made his experimental results so fruitful.

Davy Medal

The DAVY MEDAL is awarded to Prof. Alexander Robertson, professor of organic chemistry in the University of Liverpool. He achieved a world-wide reputation as an authority on the organic chemistry of those natural products belonging to the class of compounds containing heterocyclic oxygen atoms. Arising from his early studies with Sir Robert Robinson on anthocyanidins and anthocyanins, Robertson developed an interest in the natural glycosides, and his first major studies were in this field. He developed new methods of synthesis for biosides of phenols, and by a combination of analytical and synthetic procedures he established the structures of a large number of these substances, including indican, the natural glycoside of the indigo plant, and ruberythric acid, the glycoside of madder.

Following on these investigations, he commenced his long series of studies of hydroxy-carbonyl compounds, and on heterocyclic oxygen compounds of natural occurrence. Compounds of these types include many of the familiar non-nitrogenous bitter principles of plants, as well as a variety of fish poisons and insecticides. Over the past twenty years Robertson's output of research in this field has been prodigious, and his work throughout has been marked by brilliance, alike in perception and execution. Among his many triumphs may be mentioned his clarification of the chemistry of the rotenone group of insecticidal compounds from derris root, of usnic acid from lichens, and of the complex natural colouring matters, rottlerin from kamala, dracorubin from dragons blood resin, and the pigments of the insoluble red woods. It is worthy of particular mention that in all these cases Robertson was dealing with problems which had baffled many investigators and were regarded as chemical puzzles; such they would have remained but for his brilliant synthetic studies on oxygen-ring compounds in general. Further development from this point led to his clarification of the structure of the natural furano-coumarins and furano-chromones and of the mould colouring matters, citromycetin and citrinin. In another colouring matter isolated from a micro-organism, violacein, Robertson encountered the remarkable oxidation of hydroxy-indole derivatives, which is bound up with the problem of melanin formation in animals, and he has since then made, and continues to make, notable contributions to our knowledge of the mechanism of melanin formation.

In short, Robertson is a brilliant organic chemist, who has not only solved a long series of structural problems which had baffled earlier workers, but in so doing has opened up new fields of study.

Darwin Medal

The DARWIN MEDAL is awarded to Prof. John Burdon Sanderson Haldane, Weldon professor of biometry in University College, London, for his work on the analysis of the causes of variation and of the mechanism of selection. The conclusions derived

from his researches have permeated practically every field of evolutionary discussion, and his ideas have fundamentally altered our knowledge of evolutionary change.

For many years he has insisted that a proper study of evolution involves the development of methods for investigation of the genetics of populations. His mathematical treatment of the question was the first of its kind, and has played a large part in the great development of understanding of evolution during the past twenty-five years.

He has been a pioneer in applying biochemical knowledge, especially of enzymes, to problems of genetics. His contributions to strictly genetical problems are fundamental. They included some of the earliest demonstrations of linkage in birds and mammals and of partial sex-linkage in man. He made the first investigations of human mutation-rates (simultaneously with L. S. Penrose), has studied interspecific hybrids and discovered the rule by which their sex is determined. He was one of the first to develop a theoretical treatment of polyploidy and to show its evolutionary significance.

He has thus made first-rate contributions by his detailed researches, his mathematical treatments and his general analysis of evolutionary problems, to the field of Darwin's work.

Buchanan Medal

The Buchanan Medal is awarded to Sir Rickard Christophers. Many of the early papers by Christophers appeared in the reports to the Malaria Commission of the Royal Society from 1900 onwards. He was one of the two principal authors of these reports, which make a fundamental contribution to our understanding and prevention of malaria, the greatest cause of sickness in the tropics.

Fifty years ago, Christophers originated the fundamental idea that malaria is not transmitted by *Anopheles* mosquitoes in general but by certain species of *Anopheles*, not by others: much turned on the insect's choice of host, and both in Asia and Africa it was shown that different species of *Anopheles* breed in different types of water: the control of the dangerous species is still based on this, and 'species sanitation' constitutes a fundamental advance in public health.

Turning to the disease itself, Christophers distinguished several main types in the epidemiology: he developed new quantitative methods. He observed that, in such a region as the Punjab, people are not soaked in malaria; they possess, therefore, little immunity, with the consequence that immense fulminant epidemics may occur at intervals of a few years. This he contrasted with the hyper-endemic type of malaria which occurs in places where people are exposed to malaria at all seasons and in every year; in such places the disease may indeed be grave, especially to children, but it does not occur in great outbreaks.

It is not too much to say that nearly all our basic knowledge of the conditions leading to the spread of malaria arises from investigations carried out, mostly in India, by Christophers and those immediately associated with him.

Sylvester Medal

The Sylvester Medal is awarded to Prof. Abram Samoilovitch Besicovitch, Rouse Ball professor of mathematics in the University of Cambridge. Besicovitch left Russia in 1925 and came to Great Britain after working for a short time with Harald Bohr in Copenhagen; he is one of the foremost authorities in the world on the theory of plane sets of points and the area of surfaces. His first notable work lay in the generalization of the theory of almost periodic functions of Harald Bohr. By dropping the condition of continuity of the functions, he obtained a theorem of the Riesz–Fischer type, thus rounding off the theory in an essential point. Later, and in collaboration with Bohr, he showed how to develop the whole theory from the point of view of function spaces. His book, published in 1932, is still the standard work on the analytical side of the theory.

During the 'thirties he published a large number of papers on various topics of analysis; but probably the most significant of his papers in this period are those devoted to the study of the structure of sets of points in the plane, which are among the deepest and most original contributions to modern analysis.

In recent years he has made a number of fundamental contributions to the theory of the area of surfaces in space. He has also solved a number of isoperimetric problems and made a very important contribution to the additive theory of numbers.

Hughes Medal

The Hughes Medal is awarded to Prof. Philip Ivor Dee, who is distinguished for his application of the cloud-chamber technique to the study of nuclear transmutations. After early work with Prof. C. T. R. Wilson, he studied the interaction of neutrons with electrons immediately after the discovery of the neutron by Chadwick, and showed that the neutron-electron interaction was extremely small. He then applied the cloud chamber to the study of the transmutations of lithium and boron by high-speed protons which had been discovered by Cockcroft and Walton. His very elegant photographs showed directly and proved conclusively the disintegration of boron into three alpha-particles. He then turned to the study of the disintegrations produced by heavy hydrogen, which had been discovered by Rutherford and Oliphant. The cloud-chamber evidence proved that the disintegration of deuterium by deuterons could take place either into a proton and a triton or into a neutron and helium-3. This is one of the most important of the nuclear transmutations.

Dee was then largely responsible for the design and installation of the one-million volt proton/deuteron accelerator in the Cavendish Laboratory during 1936–39. This equipment was remarkably successful and has been copied by numerous laboratories. It enabled a new series of refined experiments on nuclear transmutations to be undertaken. Under his direction, the High Voltage Laboratory carried out a large number of investigations on the transmutation of the light elements which clarified many important aspects of such transmutations.

Dee left the Cavendish Laboratory with his group on the outbreak of war in 1939. He was responsible at the Telecommunications Research Establishment for the development of the technique of microwave radar—probably the most important technical development of the War.

At the end of the War he was appointed to the chair of natural philosophy in the University of Glasgow and has there built up an active school of nuclear physics. He has equipped a high-voltage laboratory,

and installed a 30-million volt electron synchrotron and a 330-million volt electron synchrotron. He has recently published an important paper with Richards showing that alpha-particles produce chemical effects in liquids through the interaction of short-wave radiation.

The Council has already presented to the Fellows its report on the work of the Society during the past year—the 290th year of its existence. It was a year in which we had to sustain a grievous loss in the death of our Royal Patron, King George VI. The Queen has been graciously pleased to become Patron of the Society, and the Fellows will rejoice to know that our historic Charter Book is now adorned with Her Majesty's signature on the appropriate heraldic page, a reminder of the great privileges which the Society has always enjoyed since the days of its Royal Founder.

There are certain items in the Council's report to which I may refer. There is, for example, the encouraging fact that the delays in publication of papers in the *Proceedings* and *Transactions* show a steady reduction. The average time between the receipt of a paper and its publication has been 26 weeks for *Proceedings A*, and since June 12 papers have taken less than 20 weeks. But costs continue to rise and, apart from our own publications, there is the very serious problem of financing the publication of abstracts, particularly in the field of chemistry. We must not rely unduly on the help of industry and of Government funds for such important work; but I should like to take this opportunity of thanking those industrial concerns which have contributed so generously towards it. All of us, scientists, industrialists and Government alike, know the great value of our abstracting publications, and none of us can afford to relax our efforts to keep them flourishing.

These abstracting services show us how scientific knowledge is expanding; but before tendering advice about them we ought, no doubt, to set our own house in order. The Royal Society Library contains a wealth of scientific material and papers not yet adequately catalogued: we were most grateful to the Pilgrim Trust for the grant it gave three years ago to enable us to make a calendar of the Society's papers from 1800 onwards, and it has now earned our renewed gratitude by providing a further grant.

One other benefaction should be mentioned. As the Treasurer reported last year, the Society has received the sum of £70,000 on account of the John Joseph Jaffé bequest. During the year we have been able for the first time to award a "Mr. and Mrs. John Jaffé Donation" from this bequest. This first award was made to Sir Geoffrey Taylor, who retired from the Yarrow professorship in February 1952 but continues to direct an important research programme in Cambridge. When we receive the whole of the bequest, we look forward to making many further awards in a manner which will be in accordance with the wishes of the donor and will render great service to the advancement of science. We are very grateful to the late Mr. Jaffé for this bequest.

There is one item which concerns our staff. At the end of the year Mr. P. D. Rogers, deputy assistant secretary, is due to retire from the Society's service after being with us for more than forty years. He began as a junior when Sir Archibald Geikie held office and has served in all under ten presidents of the Society. He is now our Clerk of Council, and the Society will know that the smooth running of our business owes much to the care and efficiency of his work. During these past forty-one years he has seen the Society's responsibilities expanding over a wider and wider field. We are extremely sorry to see him go and we congratulate him on his long and successful career at Burlington House.

NEW TECHNIQUES IN THE STUDY OF THE NERVOUS SYSTEM

It is not usual at the anniversary meeting of the Society to give more than the names of those Fellows of the Society who have died during the year, but there is one of them who occupied a special place as much by reason of his personal qualities as of his great services to science over many years. Charles Scott Sherrington was president during 1920–25, he was a physiologist of world-wide renown, a man of letters as well as a scientist and one who inspired universal affection. Few scientists of our time have been so well qualified to judge the advance of human understanding of the natural world, for he lived long enough to have witnessed most of the great achievements of the present era and he had made an intimate study of the science of the Middle Ages, when the schoolmen and the alchemists were as satisfied with their theories as we are with ours.

But Sherrington was primarily a physiologist and so was interested in the development of ideas concerning the living organism—"Man on his Nature". In his own work he had seen the transformation of physiology from a science still largely anatomical and concerned with the description of bodily adjustments into one which is more concerned with the cell and makes full use of the most advanced techniques of physics and chemistry. His work reflected this change in that his earlier experiments dealt with reflex movements and his later with the control of the individual motor units; but its enduring quality comes from the fact that he was always alive to the whole range of biological inquiry. He thought of cell activities in their relation to the organized behaviour of the whole animal.

He studied the integrative action of the nervous system. That was the title of his classical series of lectures published in 1906. His method was to select a relatively simple movement which could be evoked under standardized conditions, like the withdrawal of the foot from a noxious stimulus, to study the whole apparatus of sense organs, nerve fibres and central cell stations concerned in such a reflex and by doing so to establish the general principles by which simple movements are compounded to give more elaborate activity.

His book was reprinted by the Physiological Society when the International Congress met in Oxford in 1947. It needed no alteration, and although a great deal had been found out about the nervous system since 1906, the general conclusions are still the only general conclusions which can be drawn. But this is not so much a confession of the failure of neurologists to solve their problems as an index of the fundamental difficulty, at all events the fundamental nature, of the main problem, which is to construct a physiological picture of intelligent behaviour.

So much has been written about this in recent times that there is no point in elaborating it now, but our picture of the nervous system is extending in several

directions; changes of emphasis have followed new techniques and it may be worth considering where they may be expected to lead.

The most striking advance has come from the great development of techniques for studying what goes on in the very small units of which the nervous system is built up. The new methods of microscopy are scarcely old enough to have borne fruit, but the electronic amplifier has made it a relatively simple matter to study the electrical activity of single nerve cells, and there are corresponding advances in the technique of manipulating very small and delicate living structures.

An early result of the introduction of the amplifier was to establish the nature of the signals by which the nervous system carries out its business. They are all of them trains of nerve impulses, brief outbursts of activity revealed by their electrical effects, travelling rapidly along the nerve fibres and succeeding one another at intervals as short as 1/1,000 sec. Recording them has shown what kind of information can be carried by the nerve fibres and how the sense organs react to stimuli.

But although these electrophysiological methods have been in use for upwards of twenty-five years, our knowledge of the sense organs is still very far from complete. It has been biased, naturally enough, in favour of human sense organs, and it is only in recent years that we have begun to learn much about the sense organs of animals constructed on a different plan or for a different environment. For example, the most remarkable because the most unexpected recent addition to sensory physiology has been Lissman's discovery that certain fish can guide themselves by the aid of the currents which they produce from special electric organs in their bodies. The massive electric discharge of the torpedo was described in a communication to the Royal Society by Walsh in 1773. It is powerful enough for the torpedo to use it as a weapon of offence; but it appears that various freshwater fish have electric organs too small to have any paralysing effect, but large enough to set up pulses of current in the water for their own sense organs to detect. Regions of different conductivity near the fish will distort the pattern of current flow, and if the sense organs are adequately spaced they will reveal the distortion and therefore the presence and the position of the object. Those who attended the soirée last May will have listened to these guiding discharges made audible by connecting electrodes in the water to a loud-speaker system. Bats are known to guide themselves by the sounds they produce, and this is another example of an animal generating the stimulus to be used by its own sense organs. Mankind has learnt to produce such guiding stimuli artificially, as when we light a lamp to see our way in the dark, but the sense organs were evolved without consideration of all that man might do. Our semicircular canals are excellent devices for signalling the limited rotation of the head on the trunk; but they are worse than useless if we subject ourselves to continued rotation on a turntable. In the same way this electric signalling system in fish breaks down when faced with the results of human activity. Rushton has recently investigated the reactions of the eel, *Gymnotus*, an animal which has two kinds of electric organ, a larger one for stunning its prey and a smaller one for detecting it. The system enables the eel to detect and eat the small fish, which in natural surroundings are the only objects likely to have a high conductivity; but if metal electrodes are placed near it the eel detects and eats these too. Indeed, the stomachs in electric eels which have lived in civilized regions are said to contain an assortment of scrap metal erroneously swallowed because the electrical detecting system was not designed to exclude such man-made objects.

Animals which live on land could have little use for organs the sole function of which is to produce electric currents, but small electric currents are, in fact, produced whenever nerve fibres or nerve cells are in action. These action currents are due to ionic interchanges at the cell surface. They play an essential part in nervous transmission; but their study is important not only because they show how information is transmitted but because they give a clue to the molecular changes in the cells. The biophysical problems arising from the phenomena of animal electricity have been recognized since the days of Galvani, and it is in this field that the most rapid progress is now taking place.

It has come from three technical developments: the use of very large nerve fibres, of very small exploring electrodes and of radioactive tracers. All three contribute to the study of the living cell surface and the molecular changes which it controls. Most vertebrate nerve fibres have a diameter of less than 10 μ, and a single fibre is formidable material for the biophysicist; but the giant nerve fibres of squids are large structures, half a millimetre or more in diameter. They were introduced to physiology by Prof. J. Z. Young, and their use has made it possible to study the interior of the fibre as well as the exterior. Later it was found by Ling and Gerard that tubular electrodes of hard glass, with a diameter of 1 μ or less, would penetrate the cell membrane without appreciable damage, so that results obtained with giant fibres can now be extended to other types of cell structure.

The results have given us a new outlook on cell activity. This year, for example, Prof. A. L. Hodgkin and A. F. Huxley read a paper to the Society describing the sudden changes in permeability which occur in the cell membrane when it is subjected to a current which tends to depolarize it. It used to be thought that the result of depolarization was to make the membrane generally permeable to all ions, but the change is much more remarkable; in fact, during activity the relative permeability to different ions is the reverse of what it is during rest.

At rest there is a higher concentration of potassium and a lower concentration of sodium ions in the fibre than in the fluid outside it, and the surface membrane prevents the free diffusion which would equalize these differences. During each pulse of activity, started by depolarizing forces, there is a sudden movement of sodium into the fibre, succeeded almost at once by a movement of potassium out of it. The actual entry of sodium and loss of potassium ions has been measured quantitatively by Keynes and others using radioactive ions. The quantities involved in a single impulse are very small; Keynes and Lewis reckon it as 3–4 $\mu\mu$ mol. through 1 cm.^{2} of surface, but to maintain its state the fibre must restore the potassium it loses and get rid of the sodium which it gains at each impulse.

The biophysicist has therefore two sets of problems to study: those of the surface membrane, which starts and stops this ionic interchange; and those of the cell metabolism, which keeps up the differences in concentration of sodium and potassium in the resting state, pumping out the sodium and restoring the

potassium. As Hodgkin points out, although the loss for each impulse in the giant nerve fibre of the squid is only a millionth of the total internal potassium, in the very fine dendrites of the central nervous system the internal store would fall much more rapidly if it were not replenished. Where continuous activity is the rule, as in the controlling regions of the central nervous system, there may well be considerable fluctuations in the internal levels of potassium and sodium ions which may have a profound effect on the working of the cells and about which we are still completely ignorant.

This attack at the biophysical level is beginning to reduce the problems of cell organization in the nervous system to the molecular level. It is likely to explain many of the characteristic properties of nervous tissue, and certainly a clear picture of the cell mechanism must be the basis for any picture of the nervous system as a whole. But the title of Sherrington's book reminds us that most of the picture is very far from clear. The cell units are there to give the integrative action of the whole animal, and we have to find out how they are organized into the nervous system as well as how each one stores and discharges ions.

The problem of organization is partly anatomical—deciding what each fibre tract and cell mass contributes to the total activity. Here there has been and will be a steady advance. But the special feature of the nervous system is the wide variety of action it controls and its power to make behaviour appropriate to future as well as to present needs. It is, in fact, the great diversity of its interests which makes it so difficult to proceed.

Since we are still searching for the physical changes which accompany learning, the changes—structural or molecular—which make the nervous system react differently after training, there is little as yet to bridge the gap between the biophysics of the nerve cell and the fully elaborated activity of the whole system. If we could find, for example, the cell changes which establish a conditioned reflex, we should still have only the general principles of nervous organization. We could not forecast in detail how any particular nervous system would react unless we knew every detail of its past history.

The sort of difficulty which confronts us in studying the organization of the brain is illustrated by recent work which aims at plotting by electrical methods the more remote consequences of the arrival of a sensory message in the brain. Lilly in the United States and Grey Walter in Britain have already made some very interesting observations by different techniques; but to describe their results adequately is already a considerable feat, involving the reduction of four-dimensional patterns to a two-dimensional page.

To understand the integrative action of the nervous system we have to relate the unit to the whole system and the system to the work it has to do. The study of the unit is advancing rapidly, though it is mostly concerned with the immediate response to stimulation and we know little about slower and more persistent effects. When we do know more, it may be that the general plan on which the units are organized will become much clearer. Perhaps a complete revision of outlook may be necessary. At all events there is no need to be pessimistic. There is a wealth of new material and new methods, and a branch of natural science is in a healthy state when it has advanced to the stage where its traditional conceptions begin to look inadequate.

BIOLOGY OF DESERTS

A SYMPOSIUM on "The Biology and Productivity of Hot and Cold Deserts", organized by the Institute of Biology, was held at the Royal Institution during September 25–27. It consisted of six sessions devoted to various aspects of desert biology: climate and physical environment; plant ecology; entomology and ecology; economic aspects; and mammalian physiology and ecology.

Dr. Edward Hindle, president of the Institute, in an opening speech in which he welcomed delegates from abroad, mentioned that the United Nations Educational, Scientific and Cultural Organization showed a special interest in the symposium and contributed towards the expenses of speakers from overseas. Brigadier R. A. Bagnold (the well-known desert explorer) then communicated an introductory paper on the geography of deserts by Prof. Frank Debenham (formerly professor of geography in the University of Cambridge), who was not able to attend in person, and read his own paper on the physical aspects of dry deserts. In the first of these papers, it was pointed out that the distribution of deserts in the world is due mainly to the circulation of the atmosphere, particularly in its lower layers, whereby certain areas are starved of moisture. In addition, many local factors affect the intensity of desert conditions, and excessive insolation by day tends to produce extreme instability in the rainfall. Brigadier Bagnold then said that this intermittent precipitation is variable not only in time but also in place, and only by nomadic wandering over large areas can its effect be exploited. If nomadism were prevented for political reasons, much of the desert would become totally unproductive. Prof. F. W. Shotton (University of Birmingham) emphasized the salinity of most underground desert waters, which are consequently unsuitable for irrigation. Although in semi-desert areas such as southern Palestine considerable development of underground waters can still be hoped for, the prospect for the greater part of the true deserts must always be poor. Dr. C. B. Williams (Rothamsted Experimental Station) then described three studies of microclimatic conditions made some years ago at Wadi Digla in the hilly desert near Cairo. Great variations in conditions occurred between localities only a few feet apart, particularly during the summer; but twelve metres within a cave the daily and seasonal range of temperature was only 2 deg. C. Thus by moving a very short distance, animals can escape extremes of heat and have a wide range of conditions at their disposal. In the discussion that followed, Prof. J. A. Prescott (Waite Agricultural Research Institute and University of Adelaide) pointed out that the variable and local nature of the rainfall in northern Australia has long been realized by pastoralists whose cattle, unhindered by fences, travel great distances to favourable areas, and Dr. H. Greene (Rothamsted Experimental Station) suggested that, although the violent spates of water in the wadis of the Sudan carry so much sediment that storage by dams is impracticable, the deposition of this as silt results in a natural rotation of the soil.

Dr. Hugo Boyko (chief ecologist to the Ministry of Agriculture, Israel) opened the second session with an account of the main lines of plant ecological research that are being carried out in his country. These include pasture problems and the effect of grazing, searching for food plants adapted to desert con-

ditions and for plant raw materials, and the application to biology of other branches of science such as climatology, hydrology and hydro-engineering. A paper by Prof. Th. Monod (director of the Institut Français d'Afrique Noire) outlined the distribution of the basic contracted and diffuse types of vegetation in the Sahara, and Prof. R. D'O. Good (University College, Hull) gave an account of the desert flora of the arid Bahrain Islands in the Persian Gulf. These islands are of interest in that they illustrate with peculiar clarity, and within a circumscribed area, many of the characteristic features of deserts in general. Prof. M. Zohary (Hebrew University, Jerusalem) then presented an analysis of the many hydro-economic types of vegetation occurring in the Near East deserts, and a paper by Prof. I. Reichart (Jerusalem), crediting xerothermic climates with the suppression of many pathogenic bacteria and downy mildews, was followed by a general discussion.

In the third session an exposition of phyto-sociological research carried out in French North Africa to provide a rational basis for the evaluation of the soil was given by Prof. L. Emberger (Montpellier). At Montpellier and Zurich a cartographical method has been devised to demonstrate vegetational associations which directly indicate the nature of the underlying rock, and similar surveys are now being carried out in central Tunisia and western Algeria. The secretary-general of the International Union of Biological Sciences, Prof. P. E. L. Vayssière, then described how modern methods of rapid travel have, in a number of cases, transported pests of such economic plants as dates and cotton across natural barriers of arid desert, and introduced them into oases and other areas from which they had previously been absent. Dr. B. P. Uvarov (director of the Anti-Locust Research Centre, London) gave a warning that desert irrigation schemes may increase the danger of locust infestation in other areas by providing new permanent breeding-grounds. The desert locust requires adequate soil moisture before it can increase in numbers to the point of swarming, and, both at Abyan near Aden and at Tokr on the Sudan coast, irrigation schemes have already resulted in a semi-permanent population of desert locusts. Dr. A. S. Balachowsky (Institut Pasteur) gave an account of the problems of applied entomology in the Sahara, with particular reference to the biology of indigenous species that have become adapted to feed upon cultivated plants. This was followed by a description by Prof. F. Bernard (Algiers) of the economic importance of social insects, particularly termites and ants, in the desert. Methods were suggested for encouraging useful, and for reducing harmful, species.

The microbiological formation of sulphur in Cyrenaican lakes, particularly Ain-ez-Zauia, was the subject of a joint paper by K. R. Butlin and J. R. Postgate, who led an expedition from the Chemical Research Laboratory, Teddington, to the area in 1950, and methods of increasing the yield were discussed. Prof. E. P. Stebbing (formerly professor of forestry in the University of Edinburgh) emphasized that the man-made desert is a stern reality; man has been the enemy of forests since earliest times, and large-scale clearing has resulted in erosion and the production of arid regions. Dr. S. M. Manton (King's College, London) then gave an outline of the large irrigation and development schemes being carried out in Central Asia, and of the biological research associated with the construction of the Turkmenian canal and the development of the Kara Kum desert. She was followed by Prof. J. F. V. Phillips (Achimota, Gold Coast), who discussed aspects of the ecology and productivity of the arid regions in southern and eastern Africa. The deserts themselves are of little potential productive importance, but their significance in regard to possible encroachment is profound. Mismanagement by most African and many European farmers, he said, is increasing the desiccation of the land at an alarming rate. Emphasis was laid on the role of the tsetse fly in controlling too rapid a development and on the agencies responsible for increased erosion. From experience gained while associated with the Groundnuts Scheme, Prof. Phillips gave warning of the far-reaching repercussions of insufficiently planned attempts to clear large areas of natural vegetation within a short time, and advocated ecological surveys and pilot schemes extending over at least five years. In the discussion that followed, the damaging effect of clearing forest by fire was contested by Dr. A. S. Thomas (London).

Sessions on the last day were devoted to problems of mammalian physiology and ecology. Prof. F. S. Bodenheimer (Hebrew University, Jerusalem) described research on the seasonal cycle of the gonads and endocrine glands in gazelles and camels, carried out in his laboratory at Jerusalem. This cycle is adapted to the seasonal rainfall, with the result that the young are born when vegetation is most abundant. Dr. Norman C. Wright (scientific adviser to the Ministry of Food) compared the morphology of domesticated animals inhabiting hot and cold deserts, in contrast to that of animals from non-desert areas. The majority of the former are slightly sweating species that employ polypnea as a temperature defence mechanism. Solar radiation is reduced by various protective devices which were discussed from the point of view of the histology of the skin, the hair characteristics and behaviour reactions. Suitable fodder may help to alleviate the gross heat burden. Water conservation in kangaroo-rats and pocket mice was discussed by Dr. Bodil Schmidt-Nielsen (Cincinnati), who has investigated the physiology of the desert rodents in Arizona. She found that these animals never drink, but obtain an amount of water equal to more than half the weight of the dry seeds which form their staple diet by oxidizing this food within their bodies. Evaporation from the respiratory tract is relatively small because of the low temperature of the respired air, the urine is very concentrated and the fæces contain less water than that of most mammals. The subject of heat regulation in these animals was mentioned by Dr. Knut Schmidt-Nielsen, who said that the loss of water by evaporation is avoided by living in burrows during the day and emerging only at night. If a kangaroo-rat is exposed to great heat, the fur of its throat becomes moistened with saliva, but even by this means it cannot survive for more than twenty minutes. Although the areas covered by bluebush in southern Australia have been greatly depleted during the past century, Prof. H. C. Trumble and Mr. K. Woodroffe (University of Adelaide) found that properly controlled grazing, pruning of older bushes and seedling establishment by reduction of competition for moisture from annual species could induce a general improvement. Problems of water conservation and of adaptive coloration formed the principal topics of the discussion which followed.

In the final session, Dr. J. S. Weiner (Oxford) discussed human adaptability to high temperatures

and suggested that the function of the skin pigment in the Negro is primarily to protect the sweat glands from injury by excessive ultra-violet light. Dr. Frank Marsh (London) then described experiments on rabbits subjected to great environmental heat, which threw light on the treatment of human heat-stroke, and a paper was given by Dr. Edmond Sergent (director of the Institut Pasteur d'Algérie) on the problems of populating the Sahara: he postulated that white families could never become acclimatized there as the heat is too great for the women and children, black races would find the winters too cold, and the nomads, who are camel owners, shepherds and warriors, are useless at manual work; consequently, only the indigenous negroid race could usefully multiply, and only in proportion to the amount of water available. Dr. O. G. Edholm (London) described the physiological effects of cold environment on man. He said that although acclimatization to cold occurs, it is a relatively slow process, and suggested that, in fact, man has probably evolved as a tropical animal. Sir David Brunt (formerly of the Imperial College of Science and Technology) showed by means of graphs the conditions in which office work can be carried on in the afternoon in tropical climates. The limitation appears to fall within a well-defined range of temperature and humidity.

After the discussion, Dr. Frank Malina spoke on behalf of Unesco, and Prof. J. F. Danielli (King's College, London), honorary secretary of the Institute of Biology, summed up. The latter said that, from the papers presented at the symposium, it was apparent that individual deserts present a multitude of different problems. Scientific investigation must precede development; but in most cases the major difficulties are social, moral and political, and present problems of ethics rather than of science.

The proceedings of the symposium will be published by the Institute of Biology, Tavistock House South, W.C.1. Prof. R. D'O. Good has very kindly read through this article in manuscript.

J. L. Cloudsley-Thompson

NEWS and VIEWS

Mechanical Engineering in Manchester: Prof. Jack Diamond

The Council of the University of Manchester has announced the appointment of Mr. Jack Diamond to the first chair of mechanical engineering in the Faculty of Science. This is additional to the Beyer chair (founded in 1868 and first held by Osborne Reynolds) and the chair of electro-technics (1912). In addition there are also, in the Faculty of Technology, chairs in both mechanical and electrical engineering, established when that Faculty was established in the Manchester College of Technology in 1905.

Mr. Diamond's early training was followed by an apprenticeship at H.M. Dockyard School, Chatham, from which he proceeded to the City and Guilds College, London, as a Whitworth Scholar in 1932. In 1935 he was awarded first-class honours in mechanical engineering and was elected to a Senior Whitworth Scholarship. This he held for the next two years at St. John's College, Cambridge, where he undertook research in heat transfer; he was awarded the degree of M.Sc. in 1937. Mr. Diamond was then appointed a demonstrator in mechanical sciences in the University of Cambridge and a supervisor in St. John's College, resigning in 1939 on taking a temporary commission as an engineer officer in the Royal Navy. Three years later he was appointed assistant to the Engineer Manager of Rosyth Dockyard and, after becoming a temporary lieutenant-commander (E.), retired from the service in 1944 to become a senior scientific officer in the British Atomic Energy Team at Montreal. Since 1946, he has been a senior principal scientific officer at the Atomic Energy Research Establishment at Harwell, working on the design and development of nuclear reactors and on associated heat-transfer problems.

Seventieth Birthday Anniversaries: Profs. J. Franck and M. Born

On August 26, 1952, Prof. James Franck, the director of the Fels Fund research in the University of Chicago, and formerly of Göttingen and the Johns Hopkins University, celebrated his seventieth birthday. A tribute in honour of his birthday appears in the July number of the *Reviews of Modern Physics* (24, 117; 1952). It is contributed by Prof. Peter Pringsheim, of the Argonne National Laboratory, Chicago, and consists of a short biographical article describing briefly Franck's numerous scientific achievements. Born in Hamburg, Franck studied chemistry in Hamburg and Berlin, and was appointed in 1920 to the chair of physics at Göttingen. During the thirteen years that followed, Göttingen became under Franck's direction one of the most important centres of research in atomic and molecular physics, a happy and brilliant period which was brought to an abrupt end when Hitler assumed power in Germany. Throughout his whole career, Prof. Franck's work has been characterized by a simplicity in experimental apparatus and principle: the well-known Franck–Condon principle is but an application of the law of conservation of momentum, and the Franck–Hertz experiment of 1914, for which Franck obtained the Nobel Prize a few years later, was a straightforward experimental confirmation of Bohr's atomic theory. The study of fluorescence has been Franck's main occupation, and from that he has been led more recently into the important field of research in photosynthesis. Finally, Prof. Pringsheim singles out for special mention Franck's two outstanding qualities, his obsession for science and his inexhaustible kindness. As a further tribute and one emanating from Göttingen itself, Profs. M. von Laue and R. W. Pohl, the editors of the *Zeitschrift für Physik*, have collected together in the number for September 15 (133, 1; 1952) a series of articles specially contributed by colleagues and friends of Prof. Franck and of Prof. Max Born, of the University of Edinburgh, who also celebrates his seventieth birthday this year, on December 11. Most of the articles are in German, but several are in English.

The Pharmaceutical Society: Hanbury Memorial Medal

The Pharmaceutical Society has awarded the Hanbury Memorial Medal to Prof. Gösta Edman, professor of botany and pharmacognosy in the Royal Pharmaceutical Institute, Stockholm. This Medal is given periodically for "high excellence in the prosecution or promotion of original research in the Natural

History and Chemistry of Drugs". Prof. Edman's investigations have dealt with several aspects of drugs of vegetable origin. These include studies of the ash content and the presence of silica in drugs and the application of chemomicroscopical tests. His numerous microscopical studies of structure have been directed towards the discovery of adulteration, and to the identification and standardization by structural characters of crude vegetable drugs both in the unground condition and in the form of powder. The Medal will be presented at a meeting of the Society on February 9, when Prof. Edman will give an address entitled "Ash Pictures in the Identification and Assay of Vegetable Drugs".

American Academy of Arts and Sciences: Rumford Medals

Rumford Medals of the American Academy of Arts and Sciences have been awarded to the following: Prof. Enrico Fermi, of the University of Chicago, for his studies of radiation theory and nuclear energy; Prof. Willis Eugene Lamb, jun., of Stanford University, for his studies of the atomic hydrogen spectrum; and Prof. Lars Onsager, of Yale University, for his contribution to the thermodynamics of irreversible flow. The bicentenary of the birth of Benjamin Thompson, Count Rumford, will be celebrated by the Academy in Boston during March 26–28, 1953, when the Medals will be presented and conferences arranged on the fields of science represented by the recipients. Rumford was born at Woburn, Mass., now a suburb of Boston, on March 26, 1753, and in 1796 he gave a fund to the Academy to be used for the awarding of gold and silver medals to encourage scientific investigations in the field of heat and light. To date forty-eight Rumford Medals have been awarded.

American Section of the Society of Chemical Industry: Perkin Medal

The American Section of the Society of Chemical Industry has awarded the Perkin Medal for 1953 to Dr. Charles Allen Thomas, president of Monsanto Chemical Co., St. Louis, and chairman of the board of directors of the American Chemical Society. The Perkin Medal, of which this is the forty-seventh award, is given for outstanding achievements in applied chemistry and was founded in 1906, being first awarded to Sir William Henry Perkin in commemoration of the fiftieth anniversary of his synthesis of mauve, the first synthetic dye. Dr. Thomas has made outstanding contributions to many phases of industrial chemical development—including the atomic energy programme; several phases of the pioneer development and general utilization of anti-knock, high compression fuels for internal combustion engines; important contributions to knowledge of the chemical reactions of hydrocarbons in the presence of catalysts, particularly aluminium chloride; synthesis of resins and other useful products from petroleum and its by-products; and fire-fighting devices and methods—as well as for his leadership in both the profession and industry of chemistry.

Sheep Biology Laboratory, Prospect, New South Wales

A new Sheep Biology Laboratory has recently been set up at Prospect, near Parramatta, New South Wales, by the Commonwealth Scientific and Industrial Research Organization, and Prof. C. W. Emmens has been appointed as officer-in-charge. Prof. Emmens has a distinguished record as an animal physiologist and was for many years engaged on research at the National Institute for Medical Research, London; concurrent with his new post, he will continue his present work as professor of veterinary physiology in the University of Sydney. The Prospect Laboratory will concentrate on problems of fertility and reproduction, the physiology of wool production, and sheep breeding and genetics, and it is hoped eventually to build it up as a leading world centre of information on all scientific data relating to sheep and wool husbandry, particularly the Merino and other types specially evolved in Australia. A balanced programme of both laboratory studies and field investigation is planned to develop the potentialities of healthy sheep in terms of quality and quantity of fleece, higher lambing percentages and the breeding of specialized types. Linked with the central Laboratory will be a series of sheep and wool field-stations in the major wool-producing regions, equipped to study all relevant aspects of soils, pastures, animal husbandry, disease control and plant and animal management. The Laboratory is being established on an area of 130 acres which has been carefully selected to provide good potential for pasture management and improvement and space for the cultivation of fodder crops. The full building programme will not be complete for some time, but sufficient laboratory accommodation and animal houses, feed stores, fleece and shearing sheds are now available in prefabricated buildings to enable research to be started.

Abstracting Board of the International Council of Scientific Unions

The International Council of Scientific Unions has set up an Abstracting Board (Bureau des Résumés Analytiques du C.I.U.S.) with the purpose of facilitating the work of existing well-established journals publishing abstracts of original papers in the field of the natural sciences (see p. 960). A beginning has been made in the field of physics, and two member journals, *Physics Abstracts* and the *Bulletin Analytique*, are represented on the Board. In principle, any journal can seek membership to the Board, which is constituted, under a neutral chairman, of representatives of the interested International Unions and representatives of the member journals, together with the secretary-general of the Council as an *ex-officio* member. The present constitution of the Board is as follows: *Chairman*, Dr. Verner W. Clapp (assistant librarian, Library of Congress); *Secretary*, Prof. G. A. Boutry (Paris); *Members*, Dean Elmer Hutchisson (Case Institute of Technology), representing the International Union of Pure and Applied Physics, Dr. J. H. Ashery, representing *Science Abstracts*, Dr. G. Kersaint, representing *Bulletin Analytique*, Prof. A. V. Hill (secretary-general of the International Council of Scientific Unions). Dr. L. H. Lampitt sits as an observer for the International Union of Pure and Applied Chemistry. The offices of the secretariat are at the Institut d'Optique, 3 Boulevard Pasteur, Paris 15e, where work has already begun with the aid of a special subvention from Unesco. The secretary of the Board will gladly give any information desired about the facilities which can be extended to member journals.

Preservation of the Peak District

The annual report for the year up to May 1952 of the Sheffield and Peak District Branch of the Council for the Preservation of Rural England (pp.

28; from the honorary secretary, Mrs. Gerald Haythornthwaite, Endcliffe Vale House, Sheffield 10; 1952), after expressing disappointment that the Government's nominees on the Joint Board for the Peak District National Park should include so few with knowledge and experience of rural preservation in the region, stresses the major threat to the Peak constituted by the unlimited demands of the limestone industries to encroach upon the National Park. The Joint Board has adopted the policy that, while quarrying in the Park cannot be excluded, demands should receive the closest scrutiny; but the Joint Committee for the Peak District National Park considers that, in view of proposals to demolish Eldon Hill and to extend the Tunstead Quarries eastward so as to destroy Meadow, Wormhill and ultimately the exquisite series of dales from Peak Forest to Millersdale, the time has come to make a stand for the very existence of the Park and of the Peak. Open-cast coal-mining still constitutes a threat at Wentworth Woodhouse and in the Cordwell valley, and East Derbyshire continues to lose farmlands and woods at a disastrous rate. Action has also been necessary in regard to Sheffield's Green Belt, on which housing proposals threatened encroachment, as does the Sheffield Development Plan, which fails to indicate Green Belt land as such. In conjunction with the Don Valley Amenities Society, steps have been taken to restore the lost beauty of this Valley, and the first hardwood trees of the Wharncliffe State Forest were planted during November 1951. In spite of protests, the Government has approved the use by the War Department as a training-area and mortar-range of 2,700 acres north of Upper Hulme and west of Staffordshire Roaches in one of the wildest parts of the National Park, and this is a serious loss to amenity.

Journal of the Mechanics and Physics of Solids

THE first number of a new periodical entitled *Journal of the Mechanics and Physics of Solids* (1, No. 1, pp. 76; 90*s*. per vol. (4 Nos. per vol.); London: Pergamon Press, Ltd.) appeared in October under the joint editorship of Dr. R. Hill, of the University of Bristol, and Prof. W. M. Baldwin, jun., of the Case Institute of Technology, United States. The setting-up of this journal, under a distinguished advisory board, marks a further step in the emergence of studies of solid deformation from the general wide background of physics, mathematics, physical chemistry and metallurgy. The process has been detectable for some years, and notably so since 1945, during which time a vigorous development in solid-state physics, strongly led by physicists in Great Britain and in the United States, has transformed the whole approach to the mechanics of crystals. During these years, the same fundamental problem of elucidating the mechanisms of the deformation of materials and aggregates of various kinds, both metallic and non-metallic, has engaged the attention of research workers in every branch of pure and applied science, and the result of these researches is scattered throughout the literature. The more general that deformation phenomena and theories are discovered to be, the greater does the need become for some common channel of expression. There certainly exists, then, a strong reader-demand for a publication on these lines. As for the writer of research papers, it may be said that the subject with which this new journal is concerned had grown far too large for the journals that already existed. Further, and quite simply, the subject is worthy of a journal of its own. It is clearly not the concern of a publication devoted in the main to fundamental research (and this would appear to be the case to judge from the first issue) to seek any sort of justification for its activities on practical grounds; fundamental research is its own justification. Yet those concerned with the technological development of modern machines (the word is used in its widest sense) know well that the old materials have been exploited to the limit, and far beyond the limit, and that the primary barrier to advance is not the design of successful machines, but their fabrication, for present materials cannot contain them. The importance of the subject is thus in no doubt. Pure and applied science will surely welcome the appearance of this new journal as both timely and valuable.

Fiftieth Volume of the *Journal of the Bombay Natural History Society*

ON September 15, 1883, five Scotsmen, one Englishman and two Indians met in Bombay and formed a society for the study of natural history, and this was the beginning of the Bombay Natural History Society. Three years later, though the membership was still small and confined to the residents in or near Bombay, the Society decided on the bold step of starting a journal. At this time there was only one periodical in India—the *Journal of the Asiatic Society of Bengal*—for the publication of papers on zoology and botany, and these, as a rule, of a strictly scientific character. The aim of the editors of the Bombay *Journal* has always been to publish not only scientific papers but also articles of a more popular character, and at the same time to encourage members to contribute short notes on any subjects of interest. How successful they have been is shown by the long series of volumes—the fiftieth of which has now been issued (**50**, No. 4; from the Society, 114 Apollo Street, Bombay). Many of the volumes run into more than a thousand pages and contain papers of great importance by specialists as well as popular articles such as "A Popular Treatise on the Common Indian Snakes", and the "Beautiful Flowering Trees of India", while the short notes from members have thrown much light on the distribution, etc., of both plants and animals. Though in the main the contributions to the *Journal* have dealt with the fauna and flora of India, Burma and Ceylon, there have also been a few on countries beyond these boundaries, such as "A Survey of the Fauna of Iraq" started during the First World War. At one time the membership of the Society numbered more than two thousand, and copies of the *Journal* were in practically every club and mess in India. Since 1947 the membership has decreased, but the standard of the *Journal* is as high as ever; and for this the editors are to be congratulated.

A Diffusion Reaction Theory of Morphogenesis

IN a recent publication, "The Chemical Basis of Morphogenesis" (*Phil. Trans. Roy. Soc.*, B, **237**, 37; 1952), Dr. A. M. Turing has advanced the theory that a system of chemical substances, described as morphogens, reacting together and diffusing through a tissue, may account adequately for some of the main phenomena of morphogenesis in plants and animals. The biochemical system in an embryonic tissue, envisaged as being initially quite homogeneous, that is, with a homogeneous distribution on the morphogens, may be 'triggered off' by some random

disturbance; the system then becomes unstable, the distribution of the morphogens becomes heterogeneous and later a pattern or structure may develop. Such diffusion reaction systems are considered in the hypothetical case of a ring of cells. Using the digital computer, Turing has shown that in such a system the onset of instability may take six different forms, of which the most interesting form, from the point of view of morphogenesis, consists in the development of stationary waves on the ring. This would be equivalent to the accumulation of one of the morphogens at evenly distributed points on the ring, and might account for such developments as the tentacle pattern in *Hydra* and for whorled phyllotaxis and similar phenomena in plants. A system of reactions and diffusion on a sphere, which is also considered, could account for gastrulation, while another reaction system in two dimensions yields patterns resembling dappling. There are also indications that stationary waves in two dimensions may account for phyllotaxis. Basically the theory does not involve any new hypotheses; but, assuming a gene-controlled metabolic system, it suggests that certain well-known physical laws are sufficient to account for many of the facts of morphogenesis.

Plant Raw Materials

The new botanical journal, *Materiæ Vegetabiles* (editors, Drs. C. Regal and Fr. Tobler; published by Dr. W. Junk, The Hague), of which the first number has just been issued, is essentially utilitarian in its aims. The journal, in fact, "will be dedicated to the whole domain of vegetable raw materials", and it will contain papers in which research, cultivation, extraction, amelioration, preparation and utilization are treated in their mutual relationships. The literature of plant products appears either in book-form or widely scattered in botanical, agricultural, technical, chemical and trade journals. The new journal will provide a means of bringing these important practical contributions together under one cover, and by so doing should make for a stimulation of research into the better production and wider utilization of plant products. The present number includes papers on such diverse topics as the value of Karoo veld in stock raising, flax as an oil and fibre plant in La Plata territory, the scientific basis of improved rosin production, cæsalpinias as sources of tannin, the effect of manuring on fibre content in *Yucca*, the significance of terpene accumulation in plants, and the utilization of fibre from the stems of edible bananas. The subscription for the volume of four numbers is 40 Dutch guilders.

Library of the National Institute for Research in Dairying, Shinfield

No. 4 in the Library Association series of pamphlets, "The Development and Administration of a Special Library", by C. H. Tomalin, is an account of the Library of the National Institute for Research in Dairying, Shinfield, Reading (pp. 36; 1951. 5*s*. or 3*s*. 6*d*. to members). It gives a brief account of the present stock of the Library and of the administrative methods in use, as well as of the development of the Library from the founding of the Institute until the new Library building was opened in October 1934. Primarily the Library exists to serve the scientific staff of the Institute; but it is also much used by scientific workers visiting the Institute. A card index is maintained which records all significant papers in dairy research published since 1920.

Symposium on Food Supplies

The Nutrition Panel of the Food Group of the Society of Chemical Industry is arranging an extended symposium on "Food and the Future", which will be discussed at a series of four meetings, to be held during the period December 1952–April 1953, when the topics will be, respectively: the problem of future world food supply; present methods of attack on the problem; new natural sources of foodstuffs; and synthetic food potentialities. At the end of the series, Dr. Norman C. Wright, scientific adviser to the Ministry of Food, will sum up the discussions. The first of these meetings will be held in the rooms of the Chemical Society at Burlington House, Piccadilly, London, W.1, at 6.15 p.m., on December 10, when Mr. F. Le Gros Clark will deal with a general statement of the problem of future world food supply under the title "The Yardstick of Population", and Dr. E. W. Russell will consider "Limitations affecting the World Food Supply". Visitors will be welcome. The honorary secretary of the Panel is L. C. Dutton, Virol, Ltd., Hanger Lane, Ealing, London, W.5.

Announcements

H.R.H. The Duke of Edinburgh has accepted election to honorary membership of the Institution of Mining and Metallurgy and also of the Institution of Gas Engineers.

Dr. G. R. de Beer, director of the British Museum (Natural History), has been elected *correspondant* of the Section of Anatomy and Zoology of the Paris Academy of Sciences in succession to the late T. O. J. Mortensen.

The following appointments have recently been made in the University of Sheffield: Dr. J. White, senior lecturer in refractories, to be reader in ceramics; Dr. A. S. Gladwin, to be lecturer in electrical engineering.

The following announcements have been made from the University of London: the title of reader in mechanical engineering applied to mining in the University has been conferred on Dr. William Davies, in respect of the post held by him at the Imperial College of Science and Technology; the degree of D.Sc. has been conferred on Mr. Dan Lewis, an internal student at the John Innes Horticultural Institution.

The Textile Institute, under the terms of the Cotton Industry War Memorial Trust, awards scholarships to young craftsmen in the cotton industry, which are designed to cover the cost of a three-year full-time university degree-course in textiles. Two such awards have just been made, to N. Clark (Stalybridge, Cheshire) and R. M. Watson (Manchester), respectively, both of whom have elected to go to the Faculty of Technology of the University of Manchester. This scholarship scheme was started in 1930, and to date ten awards have been made.

The annual conference of the Geographical Association will be held at the London School of Economics, Houghton Street, London, W.C.2, during December 31, 1952–January 3, 1953. The programme will include business meetings, lectures, discussions, reports and special visits to places of interest. There will also be exhibitions by the various sections of the Association and displays of books, visual aids and other educational equipment. Further information can be obtained from the honorary conference organizer, Dr. W. G. V. Balchin, of King's College, Strand, London, W.C.2.

THE PLACE OF THE SCIENTIST IN CIVIL DEFENCE

ON the evening of October 16, the London and South-Eastern Counties Section of the Royal Institute of Chemistry, the London and Home Counties Branch of the Institute of Physics and the Institute of Biology met in the City of London School to discuss the place of the scientist in civil defence. Speaking from the chair, Dr. C. W. Herd, chairman of the local section of the Royal Institute of Chemistry, said the meeting had been arranged to enable members to state their views on the employment of scientists in civil defence, and, so that they might hear something from the official angle, he was glad to introduce the Director-General of Training and the Scientific Adviser to the Home Office and also the honorary scientific advisers from the London Civil Defence Region.

In outlining points which were causing anxiety, Dr. Herd said he would be expressing personal views ; but these were based on many discussions with professional colleagues, so he thought they would be typical of the opinions of many members present. During the Second World War, there was a good deal of dissatisfaction over the status of gas identification officers in relation to other branches of civil defence. To-day he felt that official recognition of the professional standing of chemists, physicists and biologists recruited for technical reconnaissance was inadequate to enable the services of these officers to be utilized effectively. This resulted in a sense of frustration among the officers concerned and might even prevent some from offering their services. Senior technical reconnaissance officers should, in their special field, be recognized as competent advisers to civil defence controllers. At present, to be quite frank, he said, professional men lack confidence in the scientific side of civil defence at local-authority level, and this confidence must be built up if the scheme is to be a success.

After referring to other points which on present evidence seem unsatisfactory, Dr. Herd said he thought the duty of the technical reconnaissance officer should be first to the public, to inspire confidence and maintain morale ; secondly, to the civil defence controller to advise on scientific and technical matters ; thirdly, to direct technical reconnaissance ; and, finally, to collect scientific and technical information for transmission to regional advisers. He suggested that a senior technical reconnaissance officer should be free to gather around him all scientists in his district and to give them technical information and training, so that there would be a pool of trained men available to deal with any emergency in addition to those officially recruited to the headquarters establishment. Potential recruits should now be reassured regarding their status in the corps and their method of recruitment, with full information of the nature of their duties and the amount of training they would have to undertake. Regarding training, they should not be expected to attend very elementary lectures on technical subjects. Once in the corps, interest should be maintained through periodic meetings officially organized to keep them up to date in their subjects. Such meetings should not be left to the initiative of the officers themselves as happened during 1939–45.

Prof. W. V. Mayneord, one of the London regional scientific advisers, said that scientists ought to remember they are all primarily citizens, so that many of their duties are the same as other members of the community, even though the highly technical nature of modern warfare throws a special responsibility upon them. The contribution a person could make to civil defence depends upon his general training, and a physicist's first approach to the problem should be in the direction of quantitative studies of the effects of weapons in different circumstances. Such work could help the scientists officially employed on this type of research. The first thing to remember about the atomic bomb is the fear of the unknown that such a weapon creates. The trained scientist should therefore make himself as well informed as possible on all aspects of the subject, so that he might win the confidence of the public and do valuable work by allaying unwarranted fears.

Prof. Mayneord then dealt with the technical aspects of an atomic explosion, pointing out that radiation effects, though of great scientific interest, are likely to be only of secondary importance in causing casualties. Existing knowledge could be used to assess the relative values of different materials in building structures as protection against the penetration of radiation. Similarly, knowledge of the dose required to produce specific effects could be used to determine the circumstances in which the civil defence services could work in complete safety or when, in emergency, a calculated risk might be deliberately accepted. The scientist could be of value in the training of non-technical people, especially in designing the form which such instruction should take, as this is most important. To sum up, the scientist in civil defence should make himself a competent adviser in whom his controller will have full confidence, and in reconnaissance work the aim should be accurate observation and reporting of significant facts followed by informed interpretation of this information, so that it could be quickly and effectively used in dealing with the tactical situation.

Prof. H. N. Rydon who, until his recent appointment to Manchester, was also one of the scientific advisers in the London Region, then discussed the nature and magnitude of the problems resulting from the use of biological and chemical warfare. By the end of the Second World War, a new group of chemical agents had been developed in Germany, namely, the nerve gases, the characteristics of which he then described, pointing out the high toxicity of some of these in both the liquid and vapour phases. A satisfactorily sensitive test for detection has been developed, and civil defence services will be provided with a vapour detector kit capable of identifying the vapour of either mustard gas or the nerve gases in the required concentrations. The technical reconnaissance officer will be responsible for gas detection in the field and for advice on any measures required to deal with the situation resulting from an attack with chemical agents. He must in addition always be on the lookout for unusual effects, for it cannot be assumed that new and even more toxic agents will not be discovered. Systematic study of the behaviour of war gases in cities would be of the greatest importance, for there is no practical experience of their use in such circumstances. The role of the trained chemist in collecting such data would be of great value to the

scientists at regional and government headquarters, and would also be of value to the Armed Forces.

The effectiveness of biological warfare, Prof. Rydon said, is still unknown; but he thought the wild stories about a single bomb causing a widespread epidemic could be dismissed as fantastic. Comparatively little is yet known about the precise conditions required for initiating an epidemic; but it is known that to cause one deliberately at a selected time would be very difficult. Advances in the development of new drugs and antibiotics also reduce the possible choice of agents which might, even theoretically, be expected to achieve such an object. The standard of hygiene in modern organized communities is another factor which reduces the chances of epidemics being successfully initiated by attack from the air. Sabotage might perhaps remain a possibility; but this method would be localized in its effect and more amenable to control. If the epidemic idea be dismissed, biological warfare may be regarded as an exaggerated form of chemical warfare with agents having a toxicity greater than any of the war gases by a factor of tens; but against this the chances of people receiving an effective dose are probably reduced by a factor of a similar order. Biological warfare is a possibility with which civil defence must be prepared to deal; but there are still many problems connected with the choice of suitable agents and finding effective methods of using them, so that the chance of its success as a method of waging war may still be problematical. Whereas the potentialities of chemical warfare can be evaluated with fair accuracy, biological warfare is still an untried weapon.

In preparing to meet such threats, the services of trained chemists would be invaluable, and Prof. Rydon hoped that as a result of the meeting there would be a good response from chemists. The chemist could adequately perform many of the tasks connected with atomic and biological warfare as well as those in the chemical field, for his training puts him in a category intermediate between the physicist and the biologist. He hoped no one would withhold his services under the impression that civil defence is a purely passive function. The application of scientific advice could go a long way towards defeating an enemy's objective by minimizing the effects of his weapons, and this could at times be as important as the active operations of offensive warfare.

Sir John Hodsoll, director-general of training in the Civil Defence Department of the Home Office, said he could sympathize with what had been said about the Second World War, for some gas identification officers had undoubtedly been put in a difficult position; but it was hoped to benefit from the lessons which had been learnt. As to background, it was not intended that technical reconnaissance officers should take full basic training, and if this had occurred in some cases it must have been due to misunderstanding. In peace-time, scientists can make a valuable contribution by local studies designed to define the tactical problems resulting from different forms of attack.

In the civil defence organization there would be a chief reconnaissance officer at all control and sub-control centres, and he or his deputy would always be a technical reconnaissance officer, so that the controller would always have advice immediately available on the technical aspects of any problem. As regards recruitment, it is recognized that difficulties may have to be smoothed out in some cases; but it is in the local division that the technical reconnaissance officer is needed, so he must be part of the local organization. If success in any future war is to be achieved, civil defence services must be organized and trained now; for if the civilian population should give way a war would be lost even though the main military forces with all their equipment and resources still remained virtually intact. The real way to achieve this object is to see that knowledge of the right kind is available to all who should have it, and in this task the scientist can perform a most valuable work in creating the right attitude of mind among the general public.

The meeting was then thrown open for questions and general discussion, and many of the speakers elaborated the points made by the chairman in his opening address, particularly regarding the status of technical reconnaissance officers and their method of recruitment. Several speakers thought recruitment could be more effectively dealt with by making more use of the professional institutes. One speaker said that these particular difficulties are not universal, for, during the Second World War and again in the new arrangements, his relationship with his local authority was most satisfactory. Much emphasis was laid on the importance of giving scientific people the full technical details in all information furnished to them. A suggestion was made that an attack with biological agents after a heavy attack with high explosive might well produce an epidemic, since the standard of hygiene would be sub-normal and sanitation services would be disorganized. A question was asked about the arrangements for liaison with medical services, as some members feared that in certain circumstances difficulties were likely to arise. Another suggestion was made that radiotherapists, who had not apparently been considered for reconnaissance work, could be of value in the assessment of radiological hazards.

Sir Charles Ellis, senior scientific adviser in the London region, stressed the importance of the operational research approach to the type of problems which the technical reconnaissance officer would have to study. People trained to observe phenomena closely and to collate and interpret the data obtained could contribute a great deal to civil defence, and, whatever this type of work be called, such an officer should in effect be an operational research worker.

Dr. E. T. Paris, scientific adviser to the Home Office, in his summing up of the proceedings before answering some of the questions, said that the Home Office was much indebted to the three Institutes for organizing the meeting. Note would be taken of the points which had been made, and he was sure the discussion would be of value in further consideration of the problems involved. The need for scientists in civil defence had been clearly shown, as was confirmed by the discussion, since acceptance of the principle was implicit in the remarks of all speakers, however critical they might be on specific details.

The status of scientists in civil defence, Dr. Paris said, appears to be causing much anxiety. The position is that there are two distinct levels at which scientists are employed. The regional scientific advisers would assist the regional commissioners on all appropriate matters in each region, and in addition would have laboratory facilities and trained staffs for dealing with samples received from local authorities. On technical matters, they would work in direct collaboration with the Home Office and the

appropriate Ministry of Supply research establishments. At the next level, the technical reconnaissance officers are in the headquarters section of the local division so that, as Sir John Hodsoll had explained, they are part of the local authority's organization and must in the long run be recruited through that machinery, though he would take note of the difficulties mentioned. The plea for full technical information was one with which every scientist would sympathize; though there is no secrecy in civil defence as such, it has to be recognized that information of a secret nature is used in the Home Office in the study of civil defence problems, so that it is not possible to pass on some kinds of information. From his own experience, he agreed with the principle that secret information should be given only to those who must have it in order to carry out their duties. He did not think there is any greater likelihood of an epidemic resulting from biological warfare attack after an attack with high explosives than in other circumstances. In any event it is necessary to guard against the tendency to conjure up complicated defence problems by piling one form of attack on another. A very great effort is required to deliver a modern attack on an effective scale, and any complication of the kind suggested must reduce the effectiveness of the first attack without greatly increasing the chance of the second attack being more effective than if it had been delivered alone on the appropriate scale.

Suggestions had been made about the possibility of the atomic bomb being 'played down' unjustifiably, and in particular a question was asked how this could be reconciled with the casualty figures published after the visit of the British Mission to Japan. There was no intention of minimizing the potentialities of the bomb; but what had been attempted was to show how the number of resultant casualties might vary in different circumstances. For example, if it was assumed that an unwarned attack on a city with the population all exposed in the open would result in, say, 50,000 casualties, then it could be shown that if everybody was in houses of an assumed standard of construction the casualties would be reduced to 30,000 under the same attack; and again, if they were all in special shelters of a specified standard of protection, the casualties would fall to 10,000.

In conclusion, Dr. Paris said the discussion had served a most useful purpose in providing evidence of the kind of difficulties that might arise in setting up the reconnaissance service, and of the lines on which interested scientists were thinking on these matters. Since the meeting, he has agreed to consider the problem in consultation with the three Institutes which organized the discussion. J. W. MARTIN

THE ALEMBIC CLUB

By PROF. JAMES KENDALL, F.R.S.

ON October 29, 1889, the five non-professorial members of the teaching staff of the Chemistry Department in the University of Edinburgh formed themselves, under the title of "The Alembic Club", into "an unassuming body which was destined later to play a useful part in bringing historical material connected with chemistry within the reach of interested readers". In order of seniority, the original members of the Club were:

1. John Gibson. The originator, with Prof. Crum Brown, of the famous Crum Brown–Gibson rule for determining the position of radicals entering a substituted benzene nucleus. Professor of chemistry in the Heriot-Watt College, Edinburgh, 1892. Died in 1914.

2. Leonard Dobbin. Distinguished for his research work in the history of chemistry and for his translations of Ladenburg's "Lectures on the History of the Development of Chemistry since the time of Lavoisier" (1900) and Scheele's "Collected Papers" (from Swedish and German originals, 1931). He was lecturer in chemistry in the University of Edinburgh, 1914; reader, 1920. Dr. Dobbin died in March 1952 in his ninety-fourth year. For seventy-one years he was a Fellow of the Royal Society of Edinburgh (Member of Council 1904–7 and 1913–16, Curator 1934–39, Vice-president 1939–42) and for more than sixty years a Fellow of the Chemical Society and the Society of Chemical Industry. Secretary of the Alembic Club from its inception to 1946, he was its guiding spirit throughout that long period.

3. Hugh Marshall. Discoverer of the persulphates; elected a Fellow of the Royal Society in 1904. After holding a lectureship in crystallography in the University of Edinburgh, he was appointed to the chair of chemistry in University College, Dundee, in 1908; he died in 1913.

4. James Walker. For many years the leading physical chemist of Great Britain. Professor of chemistry in University College, Dundee, 1894–1908, and in the University of Edinburgh, 1908–28. He was awarded the Davy Medal of the Royal Society in 1926, and the Gunning Victoria Jubilee Prize of the Royal Society of Edinburgh in 1932. President of the Chemical Society, 1921–23. Knighted in 1921 and died in 1935.

5. Alexander Smith. Famous for his research work on the allotropic forms of sulphur and for his series of text-books on inorganic and physical chemistry. Professor of chemistry in Wabash College, Indiana, 1890–94, in the University of Chicago 1894–1911, and head of the department of chemistry in Columbia University, New York, 1911–20. President of the American Chemical Society, 1911. Died in 1922.

Members elected afterwards were:

6. Ralph Stockman (1891). Professor of materia medica in the University of Glasgow, 1897–1936. Elected a Fellow of the Royal Society in 1889. Vice-President of the Royal Society of Edinburgh, 1939–42. Died in 1946.

7. James Kendall (1929). Professor of chemistry in Columbia University, 1914–26, in New York University, 1926–28, and in the University of Edinburgh, 1928 to date. Secretary of the Alembic Club since 1946.

8. Irvine Masson (1932). Professor of chemistry, University of Durham, 1924–38; vice-chancellor of the University of Sheffield, 1938–52. Knighted in 1950.

9. Oswald James Walker (1937). Formerly lecturer in chemistry, University College, London, now on the staff of Imperial Chemical Industries, Ltd. (Plastics Division), Welwyn Garden City.

At a very early stage in the existence of the Club, the important resolve was taken to publish some of the less easily accessible chemical classics in convenient form, as simple reprints (if in English) or as translations (if in a foreign language). It was fitting that the first of these "Alembic Club Reprints" should present in 1893 Joseph Black's world-

renowned "Experiments on Magnesia Alba, etc.", in view of the author's occupancy for many years of the chair of chemistry in the University of Edinburgh. Succeeding reprints were: (2) "Foundations of the Atomic Theory", by Dalton, Wollaston and Thomson; (3) "Experiments on Air", by Cavendish; (4) "Foundations of the Molecular Theory", by Dalton, Gay-Lussac and Avogadro; (5) "Extracts from Micrographia", by Hooke; (6) "The Decomposition of the Alkalis and Alkaline Earths", by Davy; (7) "The Discovery of Oxygen", Part I, by Priestley; (8) "The Discovery of Oxygen", Part II, by Scheele; (9) "The Elementary Nature of Chlorine", by Davy; (10) "Researches on the Arseniates, etc", by Graham; (11) "Essays of Jean Rey"; (12) "The Liquefaction of Gases", by Faraday; (13) "The Early History of Chlorine", by Scheele and others; (14) "The Molecular Asymmetry of Natural Organic Products", by Pasteur; (15) "The Electrolysis of Organic Compounds", by Kolbe; (16) "Papers on Etherification, etc", by Williamson; (17) "Medico-Physical Works", by Mayow; (18) "Sketch of a Course of Chemical Philosophy", by Cannizzaro; (19) "The Foundations of the Theory of Dilute Solutions", by Van't Hoff and Arrhenius; (20) "Prout's Hypothesis", by Prout, Stas and Marignac; and (21) "On a New Chemical Theory, etc.", by Couper.

These twenty-one "Alembic Club Reprints" have enjoyed a steady sale (totalling more than 32,000) throughout the decades, and have undoubtedly proved of inestimable service to teachers, students and research workers in the domain of historical chemistry. They are issued by the Club's agents—E. and S. Livingstone, Teviot Place, Edinburgh—at a price just above the cost of publication, profits being deliberately restricted to a point that will permit the periodic replenishment of stock as particular numbers near exhaustion. No. 17 only is now out of print, because of its special expense.

In the months immediately preceding his death, Dr. Dobbin—frail in body, but with mind alert and unimpaired—became apprehensive as to the future of the Alembic Club, and the present secretary knew that he was acting as Dr. Dobbin himself would have desired when, with the approval of the other two surviving members, he proposed to the Council of the Royal Society of Edinburgh that the Council should accept the entire assets of the Club and the responsibility for the continuance of its series of reprints. This offer was cordially accepted by the Council on July 7, 1952, the general opinion being expressed that it would appear desirable not only to continue the existing reprints but also to extend the series by new issues of a similar nature in chemistry and adjoining fields of science. A committee was appointed, consisting of the president, the general secretary and the treasurer, to submit recommendations for the administration of the "Alembic Club Fund" on a broader and firmer basis under the ægis of the Royal Society of Edinburgh.

Before the Club passed under new management, however, its members decided to add to their number Norman Feather, professor of natural philosophy in the University of Edinburgh, in the hope that a precedent would thus be established ensuring the perpetuity of the Alembic Club within the Society.

The report of the Committee, approved by the Council on October 27, 1952, contained in fact a clause recommending that the Alembic Club should persist as a self-perpetuating body, fortified by the inclusion of the senior officers of the Society. Other recommendations were that an Alembic Club Prize of £50 should be awarded to a distinguished historian of science quinquennially, provided funds for it were sufficient, and that Alembic Club Lectures should be delivered at unspecified intervals. The first of such lectures will be formally entitled the Leonard Dobbin Memorial Lecture.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

GENERAL ASSEMBLY IN AMSTERDAM

THE sixth general assembly of the International Council of Scientific Unions was held in the rooms of the Koninklijke Nederlandse Akademie van Wetenschappen in Amsterdam during October 1–3. Twenty countries were represented. Prof. H. R. Kruyt, president of the Division of Sciences of the Academy and a former president of the Council, welcomed the assembly on behalf of the Academy. He spoke of the importance of the work of the Unions with their freedom to organize scientific discussions unhampered by administrative and political influences, and pointed out that he has a special regard for the Council, having attended every meeting since 1922.

The president of the Council, Prof. A. von Muralt (Switzerland), thanked Prof. Kruyt for his welcome and the Netherlands Academy for its hospitality and help in arranging the meeting. He explained how his three years experience as president have given him a great respect for the Council and some of its activities; joint commissions, symposia, support of laboratories of international standing and of established scientific services, all are of great value at the present time. The Council owes a great debt to the United Nations Educational, Scientific and Cultural Organization (Unesco) for its financial aid, and it is glad to help the Organization to carry out part of its task; Prof. Muralt also acknowledged the help given throughout by Prof. Pierre Auger (head of the Natural Sciences Division of Unesco) and his staff. International congresses have begun to grow too large, partly owing to the great increase in the number of scientific workers and the rapid growth of fresh branches of science, and the point is being reached where the present organization is becoming inadequate. One must not be too reluctant to see new Unions formed, but this must lead to difficulties in the co-ordination by a central body. There must come a time when some federal groups should be formed, intermediate between the Council and its individual Unions. He felt obliged to mention one activity of the Council, namely, the starting of an abstracting board to help in improving what has become in many sciences a difficult situation. A limit has been set at first to one subject—physics (see p. 954 of this issue). One result of improved co-ordination between existing abstracting journals has been a considerable speeding-up of the publication of abstracts.

After a tribute to the work of the Council and its Unions on the scientific side, Prof. Auger pointed out a gap between the purely scientific aspects and the financial and administrative ones. Those responsible for the latter side, he said, do not always understand the needs of those responsible for the former. One

instance of this is the lack of sufficient representation of science in the national delegations to Unesco. Prof. Auger put forward a proposal, which would be followed up in 1953, to form a scientific advisory committee on international scientific problems, and he thought that this might fill the gap.

Four countries which had joined the International Council of Scientific Unions since the last general assembly were then welcomed by the president, namely, Israel, Thailand, Spain and the German Federal Republic.

The International Mathematical Union was admitted as a new adhering organization. It was reported that the executive board had accepted provisionally an application from the Union of Physiology, and had not accepted applications from International Unions of Biochemistry, Nutritional Sciences, Scientific Psychology, Scientific Study of Population, and Philosophy of Sciences. A discussion followed in the case of the Union of Biochemistry, and it was agreed to recommend the continuance of discussions between representatives of the Union and of the Section of Biochemistry of the Union of Chemistry in the hope that an agreed solution of the problem might be found; a member of the Council would be ready to assist in these discussions as an independent observer.

Certain changes of statutes were made: these included the creation of the post of treasurer, to lighten the task of the general secretary; the removal of the figure of the annual contribution due from countries and unions from the statutes (power was given to the general assembly to fix it for three years at a time); and a tightening of the conditions governing the admission of newly formed Unions.

A discussion took place on the plans for an International Geophysical Year in 1957–58, a successor to the International Polar Years of 1882 and 1932. On this occasion observations would be made not merely in polar regions but also in low latitudes. The proposal came originally from the Joint Commission on the Ionosphere, but it was supported by the Unions of Astronomy, Geodesy and Geophysics, Radio-Sciences, Physics and Geography; the World Meteorological Organization is also co-operating. A small co-ordinating committee has been formed and it will meet very shortly, its convener being Col. E. Herbays, general secretary of the International Scientific Radio Union. Countries adhering to the Council have been asked to form national committees which would carry out the programme once it has been formulated, and the steering committee will, in due course, be enlarged. Other countries outside the Council are also being approached. Proposals for a redetermination of the network of world longitudes in the year 1957–58 were referred to the committee for inclusion in the general scheme. There was general agreement that a few special problems should be tackled: this was better than an attempt to gather a mass of observational data. As an example, the morphology of magnetic and ionospheric storms was mentioned by Prof. Berkner as a suitable problem. The year 1957–58 was selected as being one near sunspot maximum.

The assembly decided to urge its national adhering bodies to press for greater scientific representation on the national delegations to Unesco, and it also asked delegates to press for support of two international agreements drawn up by Unesco, on the importation and on facilitation of circulation of educational, scientific and cultural materials.

It was agreed to sever connexion with the Committee on Science and Social Relations, which has become a Joint Commission with the International Council of Philosophy and Humanistic Studies. The interests of the Committee had tended to move over from the purely scientific to the human and social side. After a discussion on the activities of the International Abstracting Board, it was agreed that to avoid confusion it should be known as the "I.C.S.U. Abstracting Board" or the "Bureau des Résumés analytiques de C.U.I.S.".

Sir Harold Spencer Jones, the Astronomer Royal, expressed the thanks of the assembly to the president for his distinguished services—the grace, humour and firmness with which he had presided over their meetings during the past three years, and also to the retiring general secretary, Prof. F. J. M. Stratton (Great Britain) for his devoted labours on behalf of the Council over a period of fifteen years.

The bureau of the Council for the next three years was elected as follows: *President*, Prof. B. Lindblad (Sweden); *Retiring President*, Prof. A. von Muralt (Switzerland); *Vice-Presidents*, Prof. H. Solberg (Norway) and Col. E. Herbays (Belgium); *Treasurer*, Prof. W. Albert Noyes (United States); *Secretary General*, Prof. A. V. Hill (Great Britain); *Members*, Prof. J. Pérès (France) and N. Kameyama (Japan).

SEVENTEENTH INTERNATIONAL GEOGRAPHICAL CONGRESS, WASHINGTON, D.C.

SINCE 1871 an International Geographical Congress has been held normally every three or four years, during the past half-century under the auspices of a continuing body, the International Geographical Union. The seventeenth Congress was held in Washington, D.C., during August 7–16 and attracted a record number of approximately fifteen hundred participants. Of these, more than twelve hundred were in personal attendance, and despite the difficulties of travel and dollar shortages some five hundred delegates from overseas countries were present, including approximately fifty from Great Britain.

To enable visiting delegates to see as much as possible of the work of their American colleagues, a number of other meetings were arranged at convenient times.

This is the centenary year of the American Geographical Society in New York, and the Society held open house during August 4–6 at its delightful premises in Broadway at 156th Street. At a special meeting of the Society, visiting scientific workers were honoured, Mr. J. M. Wordie, president of St. John's College, Cambridge, and president of the Royal Geographical Society and leader of the British delegation, receiving the Daly Medal.

During August 6–7 the Association of American Geographers and the National Council of Geography Teachers met simultaneously in Washington, D.C., and their meetings and joint banquet were attended by many delegates.

The attendance of so many from overseas in the United States was made possible by a generous provision of travelling fellowships and grants, particularly from the Wallace W. Atwood Senior Fund,

administered with great generosity by his widow and family. Many American universities had previously arranged visiting professorships or lectureships, and those who gathered at Washington had, in many cases, already spent some time in different parts of the United States.

Nearly all the meetings were held in the Statler Hotel, where facilities had been arranged for a magnificent display of maps from many countries. After the official welcome, the opening general assembly and the official reception on August 8, the general arrangement was to have concurrent section meetings in the morning, and in the afternoons to have concurrent meetings of those commissions which had been carrying on the work of the Union since the preceding Congress at Lisbon in 1949.

Certain broad topics of current world importance were considered by a series of symposia, and for all these important meetings simultaneous translations into French, Spanish and English were available. The symposium on tropical Africa, under the chairmanship of Prof. Derwent Whittlesey (Harvard University), reviewed the progress of investigations in both the east and west. The necessity for continued study of those factors which naturally restrict possibilities of development was continually stressed.

Another symposium dealt with world food supply, and was under the chairmanship of Dr. C. E. Kellogg, chief of the United States Soil Survey. As so frequently happens, the speakers from the Old World, notably Prof. George Kuriyan (Madras), stressed the ever-present basic problem of shortage of land, whereas the speakers from the New World were concerned much more with technical problems of development or with economic aspects.

The retiring president, Dr. George Cressey (United States) gave his presidential address under the title "Land for 2·4 Billion Neighbors". The facts adduced leave no doubt that population is increasing far more rapidly than world food supply, and that the long-range solution, given the continued population increase, must be found in sources of food, for example from the sea, not yet regarded as practicable.

A large number of papers were presented at the section meetings which dealt respectively with geomorphology, the teaching of geography, climatology, urban and rural settlement, hydrography, resources, demography, cartography, biogeography, regional geography, historical geography, trade and transportation. In some marked contrast to previous meetings, there was strong support for the section on the teaching of geography, presided over by Prof. C. A. Alagoz (Turkey). Throughout the world there is the growing feeling that international understanding is threatened by the continued ignorance of the citizens of one country concerning the rest of the world, as well as, very often, ignorance of their home country. Instruction in this field is particularly weak throughout the schools and most of the universities of the United States; large gatherings of delegates pressed for a commission to examine the position and to make recommendations. Several of the sections showed an increasing awareness of the need for the application both of their methods of study and their research findings in the solution of some of the great problems of the day.

The same may be said of the afternoon meetings, when the reports of commissions, especially work carried out since the Lisbon Congress of 1949, were under consideration. The commissions reporting included those on industrial ports; medical geography (in the course of which Dr. Jacques May, head of the Medical Research Division of the American Geographical Society, displayed some of the magnificent maps he has in preparation); the international map of the world; regional planning; arid zones; world land use; periglacial morphology; and bibliography of ancient maps.

Normally a commission, limited to six full members, is appointed for one inter-congressional period but may, if its work is incomplete, be reappointed for a further period. No less than thirty-six proposals for commissions had to be considered by the executive, and many which might well have done useful work could not be appointed with any reasonable hope that even minimum financial support would be forthcoming. The final general assembly, having elected officers (see *Nature*, August 30, p. 347), set up eleven commissions to carry on the Union's work until the next Congress, which is planned to take place in Rio de Janeiro during August 1956.

The first four commissions are reappointments, and they are as follows (with the chairman shown in brackets): periglacial morphology (Prof. M. A. Cailleux, France); medical geography (Dr. Jacques May, United States); inventory of world land use (Prof. S. Van Valkenburg, United States); and bibliography of ancient maps (Prof. Roberto Almagia, Italy). A sub-committee on the study of arid zones was constituted as a full commission under the chairmanship of Dr. Peveril Meigs (United States). The new commissions are: coastal sedimentation (Dr. Axel Schou, Denmark); erosion surfaces around the Atlantic (Prof. Francis Ruellan, France); evolution of slopes, including relevant aspect of soil erosion (Prof. Pierre Birot, France, and Prof. Paul Macar, Belgium); geography in schools (Prof. Neville Scarfe, Canada); karst phenomena (Prof. Herbert Lehmann, Germany); and library classification of geographical books and maps (Prof. A. Libault, France).

The commissions are dependent to a considerable extent on the receipt of communications from those who are interested all over the world, and the chairmen may be communicated with through the secretary-treasurer of the Union, Dr. G. H. T. Kimble, American Geographical Society, Broadway at 156th Street, New York 32, N.Y. L. Dudley Stamp

INSTRUCTIONAL FILM RESEARCH

A SHORT account of the Pennsylvania State College Instructional Film Research Program was given last year in *Nature*[1], and now a report, written for this research programme, by Charles F. Hoban, jun., and Edward B. van Ormer, has been published*, which reviews the research work done on the instructional film during the thirty-odd years prior to June 1950 at the Pennsylvania State College, and also other work independent of it. In the preparation of this report more than two hundred experimental and survey studies have been examined, and more than three hundred are noted in an appendix. These references are predominantly to

* Instructional Film Research 1918–1950. Technical Report No. *SDC* 269–7–19. Pp. 200. (Special Devices Center, Port Washington, L.I., N.Y.)

sources of origin in the United States, where nearly all the research work has been done.

Systematic criteria have been applied by the authors in making a selection from the material they have examined. Summaries of all suitable studies, grouped together in relation to various aspects of the instructional film, and the interpretations arising from each group, form the bulk of the report.

General findings previously reached by the Pennsylvania organization have much influenced the theoretical basis for the grouping of these summarized studies. In the present article some of the items in this new report that have not been mentioned before, or stressed, in the Pennsylvania Technical Reports will be indicated.

The film's contribution to comprehension, rather than to rote memory, constitutes one such item. People taught with films are found to be better able to apply their learning than people who have had no film instruction. In tests carried out by P. J. Rulon[2], pupils taught by text-plus-films excelled those taught on a text-only basis by a larger margin on 'eductive' than on 'rote' questions, the ratio being 24·1 to 14·8 per cent. Performance on eductive questions could be predicted more accurately from a knowledge of mental ability and previous achievement than could performance on rote questions. Differences between rote and eductive scores were in the same direction as differences between verbal-test and picture-test scores. From this Rulon concluded that "picture tests measure eduction to a greater extent than do the verbal tests". The contribution of films to comprehension is borne out by the work of P. E. Vernon[3], who conducted an experiment on the value of the film and filmstrip in the instruction of adults, and of J. J. Gibson[4], both of which are also summarized. In Rulon's investigation the superiority of the text-plus-films over the text-only group was found to be greater three and a half months after the films had been shown than it had been immediately afterwards. Several other summarized studies show the contribution of films to a long-term retention of knowledge.

There can be symbolic or mental practice when learning a motor skill from films. Verbal formulations seem greatly to facilitate learning for some individuals. These matters—linked to the larger one of the relationship between language and thought—affect practically the part that can be played by speech in films. The work of M. A. May[5] on the psychology of learning from demonstration films, W. E. Twining[6] on mental practice and physical practice in learning a motor skill, H. A. Ruger[7] on the psychology of efficiency, and several others, is summarized and considered.

Based on the evidence of all the studies, generalization is attempted in the last chapter of the report. According to the authors, people learn more quickly, and retain better what they have learnt, when appropriate films are used than when they are not used. More learning results from a combination of films with other instructional means than by either alone. The learning from films may be of facts, of motor skills, of concepts leading to increased comprehension, and of concepts leading to the formation of attitudes and opinions. Moreover, instructional films stimulate other learning activities. It is possible for a film to be equivalent "even to an excellent instructor in so far as the instructor's function is communicating the facts or demonstrating the procedures presented in the film".

"Films have greatest influence when their content reinforces and extends previous knowledge, attitudes, and motivations of the audience." Three of the ten principles of film-influence again stress the need for specific and confined objectives when designing instructional films, including careful regard for the characteristics of the audience. Four other principles are more distinctively related to the film medium: the influence of films is primarily in their visual presentation; pictorial context is important; the treatment of a film should generally be subjective; and the rate of putting forward new facts and ideas should be properly regulated. In the final principles the importance of introductions, summaries, etc., either built into a film or provided by the teacher, and of the teacher's leadership, are emphasized.

C. DENIS PEGGE

[1] *Nature*, **168**, 775 (1951).

[2] "The Sound Motion Picture in Science Teaching" (Cambridge, Mass.: Harvard University Press, 1933).

[3] *Brit. J. Educ. Psychol.*, **16**, 149 (1946).

[4] Motion Picture Testing and Research. Report No. 7: Army Air Forces Aviation Psychol. Prog. Res. Rep. (Washington, D.C.: Gov. Printing Office).

[5] *J. Educ. Psychol.*, **37**, 1 (1946).

[6] *Res. Quart. Amer. Assoc. Hlth. Phys. Educ. and Rec.*, **20**, 432 (1949).

[7] *Arch. Psychol.*, **19**, No. 15 (1910).

THE ROCKEFELLER FOUNDATION

REPORT FOR 1950–51

A REVIEW of the work of the Rockefeller Foundation for the year 1950 was not published, because any definitive discussion of plans and programmes was impossible while the Foundation was being reorganized to meet the changing conditions of a world in transition. The review by the president, Mr. Chester I. Barnard, now published*, covers the two years 1950 and 1951, during which the Foundation's income was almost 30 million dollars, nearly 17 millions being received in 1951. Grants and appropriations totalled 11,247,964 dollars in 1950 and 21,158,880 dollars in 1951; of this, in 1951, 3,796,270 dollars went to the Division of Medicine and Public Health, which was formed in 1951 by merging the International Health Division and the Medical Sciences Division, these two bodies receiving in 1950 2,326,840 and 1,240,900 dollars, respectively. At the same time, as a further result of a survey of the Foundation's activities, the Natural Sciences Division, which received 2,092,515 dollars in 1950, was reconstituted as the Division of Natural Sciences and Agriculture, to which 3,680,208 dollars went in 1951. A closer co-ordination of all activities of the Foundation was also recommended by the Survey Commission, and Mr. Barnard reaffirms the belief that the broad basis of the Foundation's planning should be human ecology. The Division of Social Sciences received 4,585,895 dollars in 1951, and the Division of Humanities, 1,658,072 dollars; the corresponding figures for 1950 are 2,122,085 and 1,491,250, while a further 5 million dollars in 1951 went to the General Education Board.

Reviewing the work of the Foundation in public health and medicine, Mr. Barnard records that from 1914 to the end of 1951 the Foundation expended nearly 24 million dollars on medical education and

* The Rockefeller Foundation: a Review for 1950 and 1951. By Chester I. Barnard. Pp. 126. (New York: Rockefeller Foundation, 1952).

research in the medical sciences; nearly 14 millions, more than two decades of work, costing the lives of six scientific workers, went to the isolation and identification of the causal agent of yellow fever and the development of a practical method of culturing the virus for the large-scale production of the vaccine. A definitive history of this work, edited by Dr. G. K. Strode, was published in 1951 under the title "Yellow Fever", and also in 1951 the Nobel Prize in Physiology and Medicine was awarded to Dr. M. Theiler, a virologist on the team which developed the vaccine. The programme of the new Division is now being developed with four objectives: the advancement of professional education; the study of medical care; the investigation and control of specific diseases and deficiencies; and the development of the health sciences.

For the first, it is proposed to make relatively modest grants at strategic points within a faculty to strengthen its teaching, and an exploratory survey is now being made of the status of medical education in South America. The medical care programme will be concentrated on scientific aspects of training and research, especially in the biosociology of disease, in the expectation that, when research has accumulated and systematized the data into a scientific discipline, medical schools will introduce students to the practice of community medicine with an emphasis on 'social diagnosis' comparable to that on physical diagnosis. Under the third objective, special attention is being directed to the study of virus infections transmitted by mosquitoes, ticks, lice and other insects. A survey of the major virus problems of Egypt is being made in co-operation with the United States Naval Medical Research Unit, and a virus research laboratory has been established at Poona in collaboration with the Ministry of Health of the Indian Government. The fourth objective includes a grant to the University of Oregon Medical School for research in constitutional medicine, and grants for studies of child psychology and guidance, medical studies of old age, etc.

In December 1951 the trustees of the Foundation decided that experimental biology would continue to be an active interest in the natural sciences programme but on a reduced scale in the United States, and the greater part of the effort will be devoted to the promotion of scientific agriculture. The Mexican agricultural programme, on which the Foundation has spent more than 1·7 million dollars since its inauguration in 1943, is now operating on an annual appropriation of 320,000 dollars from the Foundation, with additional funds from the Mexican Government, and animal husbandry is being added to the programme in 1952, commencing with chickens and pigs. The Colombia project for the improvement of corn, wheat and other basic food crops, which received 50,000 dollars in 1950 and 135,000 dollars in 1951, has benefited in many ways from the pioneering in Mexico: some of the new varieties of wheat developed for Mexico proved to be remarkably well adapted to Colombia, and under the revised programme for the natural sciences it is proposed to extend similar operating projects in scientific agriculture to other Latin American countries. A further appropriation of 100,000 dollars was made in December 1951 to finance for three years the agricultural aspects of a six-year programme for the agricultural development of the State of Mexico, while a consultant of the Division of Social Sciences is surveying the social problems involved with the view of a co-ordinated 'human ecology' approach to the interrelated problems of food, health, education and social relations.

Apart from these agricultural programmes in Mexico and Colombia, grants made for experimental biology and related fields of science have averaged 2 million dollars in each of the six post-war years, and, of this, 1·6 million dollars was distributed in the United States; this amount is to be decreased during the next few years to about 500,000 dollars, while the grants distributed in Europe and in Latin America will be increased to at least 500,000 and 700,000 dollars, respectively, with a further 1·5 millions for the programmes operating in agriculture.

During the period under review the main interest in experimental biology has been biochemistry, and during 1950–51 grants totalling nearly 1·5 million dollars were made for this purpose, including 168,615 dollars to the Polytechnic Institute of Brooklyn for an intensive attack on the problem of protein structure. Grants for enzymology totalled 589,000 dollars, including 35,000 dollars for Prof. H. A. Krebs's work at the University of Sheffield on sugar metabolism. Some 202,000 dollars has been contributed in support of the Conservation Foundation's programme for the study of the conservation of animal and plant life, water sources and productive soils.

In the social sciences the Foundation's programme seeks to assist all the disciplines which can contribute to the development of a science of social behaviour, the application of social science to human problems, the discovery and development of social science talent or the establishment of a firm basis for social philosophy. For research in economics 400,000 dollars were appropriated in 1950 to the National Bureau of Economic Research; 140,000 dollars went in 1951 to Harvard University for Prof. W. Leontief's study of economic structure, and 122,750 dollars went in 1950–51 to the Food Research Institute, Stanford University, partly to complete a five-year study of world operations in food and agriculture during the Second World War. An additional 420,000 dollars were appropriated in 1950 for support over five years of the Russian Institute of the School of International Affairs, Columbia University, and 180,000 dollars to the International Studies Group of the Brookings Institution for research, etc., on American foreign policy. Grants were also made for several studies of problems of ageing, while in December 1951 a capital grant of 1·5 million dollars was made to the Social Science Research Council. Grants totalling 242,500 dollars have been made to the American Law Institute of Philadelphia in furtherance of the preparation of a comprehensive criminal code for recommendation to the State and Federal governments. Altogether, grants for the social sciences totalled more than 2 million dollars in 1950 and more than 4·5 millions in the following year.

A survey of opportunities in the humanities, which commenced in 1950, has led to the selection of three types of humanistic studies for support: first, language, logic and symbolism, representing the Foundation's interest in means of communication of knowledge; intercultural understanding, with the emphasis on the dissemination of knowledge; and humane values. In the first group, 50,000 dollars were appropriated for a detailed analysis and description of the Russian language, under Prof. R. Jakobson at Harvard University, and 69,000 dollars for an integrated study of the theory of language and

symbolism at the University of Michigan. In the second, 325,000 dollars were appropriated in 1950 for the studies initiated at Cornell University, with field headquarters at Bangkok, into the effects of technological and economic change on the peoples of South-East Asia, the effects of the United States and the United Nations programmes on the political structures and ideologies in the area, and the status of Chinese and Indian minority groups there. The Institute of Islamic Studies at McGill University, Montreal, has received 214,800 dollars for a five-year period, and grants totalling 194,000 dollars have been made in support of the programme of American studies, launched jointly in 1950 by the University of Tokyo and Stanford University.

The grants, totalling nearly 1·5 million dollars in 1950 and more than 1·6 million dollars in 1951, made through the Division of Humanities, were, Mr. Barnard points out, inspired by the belief that in this field, as in the social sciences, the emphasis is no longer on knowledge but rather on the contribution that may be made to the processes by which our attitudes, beliefs and judgments of value are developed, made more coherent and integrated into a harmonious pattern. If these processes are to be kept healthy in a free society, Mr. Barnard suggests that it is important, first, that the society have creative effort which is really producing new ideas and putting them into understandable forms. Criticism is also essential, to keep creative workers operating on constructive lines; lastly, what Mr. Barnard terms—for want of a more descriptive word—experience is also needed. These are among the reasons which lead the Foundation to foster research and writing in modern history—for example, dramatic writing—and to promote the freedom of the Press. Of the 3,149 applications for aid declined in 1951, 973 were for fellowships, scholarships and travel and training grants, and 618 for support of scientific research projects and teaching programmes.

UNITED STATES PULP AND PAPER INDUSTRIES

IN a world where raw materials of all sorts are at a premium, a publication, No. 7 of the Royal School of Forestry, Stockholm, entitled "U.S. Pulp and Paper Industry with Special Reference to its Supply of Raw Material"*, is of particular interest. The consumption in the United States of paper and paperboard prior to the Second World War amounted to about 50 per cent of the total world consumption, and the corresponding figure has now risen to about 70 per cent, owing to the rise in the United States domestic consumption; this latter rose from 15·2 million metric tons in 1940 to 22·5 million metric tons in 1949, the equivalent of an increase from 114 kgm. to 153 kgm. per head of the population. In Sweden, where the consumption per head is probably the largest in Europe, the corresponding consumption for the same year was 80 kgm.

The question is, how are the United States to cover their long-term needs in the way of paper and board, and fundamentally this is a question of raw-material resources. How much can they obtain from their own forests? The balance must be imported. In 1949, 35 per cent of the paper and board consumption was covered by imports in the form of paper, wood pulp or pulp wood. The consumption of pulp wood rose from 14·5 million cubic metres in 1925 to 17·8 million in 1935 and 24·2 million in 1949. In the last-named year the United States imported 4·3 million tons of paper (the bulk of it newsprint), 1·6 million tons of wood pulp and 4·3 million cubic metres of pulp wood. All the pulp wood, the greater bulk of the newsprint, and three-quarters of the wood pulp came from Canada and Newfoundland, and the balance from Scandinavia and Finland.

At the same time the forests of the United States have been yielding a progressively increasing volume of raw material. Pulp wood has increased from 12·7 to 44·7 million cubic metres between 1925 and 1949. This is partly due to the amount coming from new forests in the southern States and Pacific northwest. More intensive valuations of the volume of timber in the coniferous forests are now available, and it is apparent that over-cutting, that is, exceeding the annual increments put on, is taking place in the coniferous forests. In the hardwood forests, for long neglected, the annual increment considerably exceeds the volume felled. It is in this latter type of forest that the United States will have to look in the future for some of their requirements. In how far the annually increasing demands will be met by Canada, Scandinavia and other European countries and so forth is problematical, for Europe requires a far larger amount of these materials than are at present available to her.

* Kungl. Skogshögskolans Skrifter 7: Förenta staternas massa- och pappers-industri med särskild Länsyn till des råvaruförsörjning (U.S. Pulp and Paper Industry with Special Reference to its Supply of Raw Material). Av. Th. Streyffert. Pp. 85. (Experimentalfaltet, K.S., 1952.)

PROXIMITY OF GENES CONTROLLING THE FERMENTATION OF SIMILAR CARBOHYDRATES IN SACCHAROMYCES

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FOUR different genes in *Saccharomyces* controlling the hydrolysis of alpha-glucosidic saccharides are on the same chromosome. The genes *MA*, *MZ* and *MG* controlling the hydrolyses of maltose, melezitose and alpha-methyl glucoside are in one linkage group[1]: (1) *MA* and *MZ* were shown to be linked by frequency of recombination; (2) *MA* and *MG*, which usually recombine freely, were shown to be on the same chromosome by the spontaneous appearance of a crossing-over suppressor in one family. The observations presented here show that *SU* (which controls the fermentation of sucrose and raffinose by producing a beta-fructo furanosidase) is a member of the same linkage group. *Saccharomyces* chromosomes are extraordinarily long genetically, and in most experiments *MA*, *MG* and *SU* recombine independently. Linkage between *MG* and *SU* was revealed by the suppression of crossing-over between them, presumably due to the spontaneous occurrence of an inversion. The pedigree described below overlaps one described

earlier[1], and the two cross-over suppressors, one involving *MA* and *MG* and the other involving *MG* and *SU*, may be of common origin.

Experimental. Culture 3608 − − + (non-fermenter of maltose and alpha-methyl glucoside and fermenter of sucrose) is a progeny of a hybrid between 3228 and 3091 (− − + × + − +). The progeny were analysed only for ability to ferment maltose (since the hybrid was homozygous for *mg* and *SU*); in 16 asci, 2 : 2 segregations for *MA*/*ma* were found.

A mating between culture 5519 − − − (non-fermenter of maltose, alpha-methyl glucoside and sucrose) and 7351 + + − (fermenter of maltose and alpha-methyl glucoside and non-fermenter of sucrose) produced the tetrads analysed in family 11. Since family 11 was homozygous for inability to ferment sucrose, only two tetrads were analysed for sucrose fermentation. All eight spores were negative. A high frequency of + to − conversion was encountered in both the *MA* and *MG* genes. The following different types of tetrads were found :

	MA/*ma*	*MG*/*mg*
+ + + −	1	0
+ + − −	29	21
+ − − −	2	6
− − − −	0	1

The concept of gene conversion[2] is applied throughout in analysis of the results.

Family 12 comprised a hybrid between 3608 and 7459; twelve asci showed 2 : 2 segregations of *MG*/*mg*. Only one ascus was characterized with regard to ability to ferment sucrose; all four cultures fermented sucrose despite the fact that one parent was sucrose-positive and the other sucrose-negative. (This situation was frequently encountered while stocks were being built up heterozygous for single pairs of genes controlling specific fermentations[4]. Since both *MZ* and *SU* control the fermentation of sucrose, ratios of this type occur in *MZ SU*/*mz su* hybrids[1].)

The first evidence of linkage between *MG* and *SU* appeared in family 14. The results are summarized in Table 1. In eighteen asci, the combination *mg SU*, characteristic of culture 7554, is accompanied by the alternative arrangement, *MG su*, characteristic of the other parent, 7517: *MG su MG su mg SU mg SU*. In ten other asci two rapid fermenters, one non-fermenter and one late fermenter of sucrose appear: *SU SU su su*^{L}. The analysis of late fermenters of galactose encountered in the Carbondale stocks by Mundkur[3] has shown that they were originally non-fermenters which mutated in the selective medium to fermentative ability. On this interpretation the initial genotype of the tetrads in class 2 would be the same as those in class 1. The close linkage of the two genes found in this family makes the interpretation reasonable and supports the view that late fermenters are originally non-fermenters which afterwards mutate to fermentative ability. The asci in classes 3 and 4 are evidently the same as those in class 1 except for the failure to identify the missing members. Similarly, classes 5 and 6 are identical with class 2 except for the failure to identify the missing members of the tetrad. The anomalous ascus listed in category 7 probably represents crossing-over in the inverted region, with other complications. The two asci in classes 8 and 9 are due to the reduction of tetraploid zygotes; this is indicated by the similar excess of dominants for other factors in the same tetrads.

Table 1. Types of Asci from Family 14 showing Linkage of *MG* and *SU*

Class	Genotype				Frequency
1	*MG su*	*MG su*	*mg SU*	*mg SU*	18
2	*MG su*^{L}	*MG su*	*mg SU*	*mg SU*	10
3	*MG su*	—	*mg SU*	*mg SU*	3
4	*MG su*	*MG su*	*mg SU*	—	2
5	*MG su*	*MG su*^{L}	*mg SU*	—	1
6	*MG su*^{L}	—	*mg SU*	*mg SU*	1
7	*MG SU*	*MG su*^{L}	*mg su*	*mg su*	1
8	*MG SU*	*MG SU*	*MG SU*	*MG SU*	1
9	*MG SU*	*MG SU*	*MG SU*	—	1

No linkage was detected between *MA* and either *MG* or *SU*. Thirty-two of the asci were characterized for capacity to ferment maltose with the following results: + + + −, 2; + + − −, 29; + − − −, 1. The two + + + − asci were those in classes 8 and 9, confirming the view that they were of polyploid origin.

Family 18 comprised a hybrid between culture 7517 and 8011. It was heterozygous for both *MG* and *SU*. A single ascus analysed from this hybrid showed independent segregation of the genes *MG* and *SU*. By contrast, these markers were almost completely linked in family 14. Since 7517 was used as a parent in producing both families, the linkage of the two markers in family 14 was not transmitted through culture 7517; it must have had its origin from 7554. Culture 7554 has the same combination of factors as culture 3608, supporting the view that the cross-over suppressor was present in family 10.

Table 2. Types of Asci from Family 15 showing Independent Segregation of *MG* and *SU*

Genotypes				Classes I	II	III	?
MG SU	*MG SU*	*mg su*	*mg su*	3			
MG SU	*MG SU*	*mg su*	*mg su*^{L}	1			
MG su	*MG su*	*mg SU*	*mg SU*		3		
MG su^L	*MG su*	*mg SU*	*mg SU*		1		
MG su	*mg*^{L} *su*	*mg SU*	*mg SU*		1		
MG SU	*MG su*	*mg* —	*mg su*			1	
MG SU	*MG su*	*mg SU*	*mg su*^{L}			1	
MG SU	*mg*^{L} *su*	*mg SU*	*mg su*			1	
mg^L *SU*	*mg*^{L} *su*	*mg SU*	*mg su*			1	
MG SU	*MG SU*	*mg SU*	*mg SU*				1
MG SU	*MG SU*	*mg*^{L} *SU*	*mg su*				1

Family 15 arose from a hybrid between 7564 and 7431. Culture 7564 is a sibling of 7554 (carrying the cross-over suppressor); 7431 is a sibling of one of the parents of 7554. The segregations of *MG* and *SU* from this family are shown in Table 2; the genes were independently assorted. When the late fermenters are considered as originally negative, the following types of tetrads are found :

	MG/*mg*	*SU*/*su*
+ + − −	12	13
+ − − −	2	0
− − − −	1	0
+ + + +	0	1
+ + + −	0	1

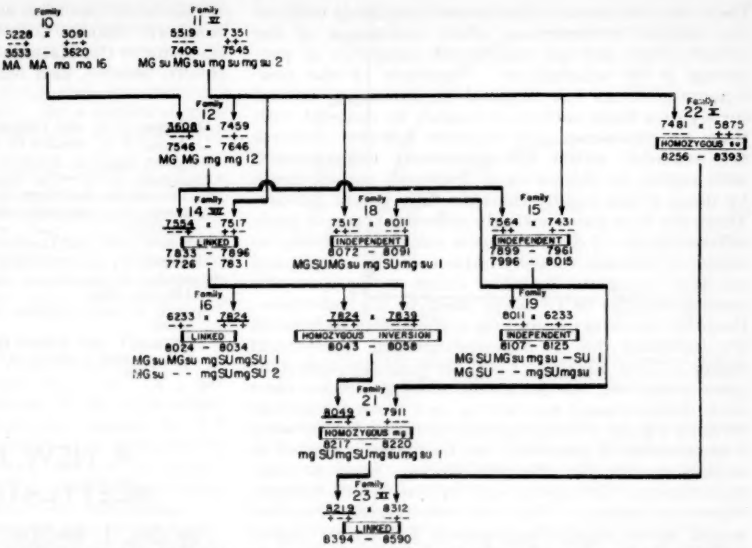
These results indicate that conversion of *MG* to *mg* and of *su* to *SU* was relatively frequent.

The high frequency of recombinations between *MG* and *SU* in family 15 shows clearly that the distance between the genes is greater than 50 morgans. This is confirmed by classifying the asci with regard to segregation of *MG* and *SU* (Class I, + + + + − − − −; Class II, + − + − − + − +; Class III, + + − − + − − +). The frequency of 4 : 5 : 4 :: 1 : II : III does not differ significantly from 1 : 1 : 4, confirming the absence of linkage. In families 15 and 18, therefore, *MG* and *SU* are independently segregated, while in family 14 they are closely linked.

Family 16 arose as a hybrid between 7824 + − + (directly descended from 7554 which carries the cross-over suppressor) and 6233 − + −. Three asci analysed from the hybrid showed that *MG* and *SU* were completely linked in this family.

Family 19 was produced by mating 8011 − − + by 6233 − + − and showed independent segregation of the genes *MG* and *SU* in two tetrads.

These results exclude 6233 as the carrier of the cross-over suppressor and establish 7824 as the carrier, since 6233 by 7824 produced a hybrid in which linkage was complete, while 6233 by 8011 (the latter also carrying the combination *mg SU*) produced tetrads in which independent assortment occurred.



Pedigree showing the origin of a cross-over suppressor in the alpha-glucosidase chromosome in the Carbondale stock of *Saccharomyces*. Arabic numerals designate the families of interest; the Roman numerals indicate families described previously (ref. 1). The + and − signs under the serial numbers of the parent cultures indicate fermentative ability with regard to maltose, alpha-methyl glucoside and sucrose, in that order

A hybrid was made between 7824 and 7839, both of which carried the inversion. An offspring from this hybrid (8049) was mated to 7911 (descended from family 15 in which independent segregation of *MG* and *SU* occurred). All the *mg SU* offspring of family 21 should carry the inversion. Family 23 was produced by mating an *mg SU* culture from family 21 (8219) with culture 8312, descended from a line in which the inversion did not occur. Thirty-three asci were isolated and analysed (Table 3). No recombinations occurred in the twenty-seven tetrads of class 1. The su^L spores found in tetrads of class 2 suggest the conversion of a dominant gene to a recessive and a later back-mutation. Conversion of *mg* to *MG* occurred in asci of class 3 and *MG* to *mg* in those of class 4. Conversion of *su* to *SU* occurred in the class 5 ascus. Family 23, like family 14, was heterozygous for *MA*/*ma*. No linkage was detected between the *MA* locus and the tightly linked *MG SU* genes. The frequencies of the three classes of *MA MG* tetrads were: type I, 5; type II, 4; type III, 20; this is in complete agreement with the theoretical expectation of 1 : 1 : 4. The following tabulation shows the frequency of conversion of *MG* and *SU*:

	MG/*mg*	*SU*/*su*
+ + + −	2	1
+ + − −	30	30
+ − − −	1	2

The fact that regular segregation of one allele is accompanied by irregularities in the other shows that the two effects arise from different loci although they are completely linked in some families.

TABLE 3. TYPES OF ASCI FROM FAMILY 23 SHOWING LINKAGE OF *MG* AND *SU*

Class	Genotype				Frequency
1	*MG su*	*MG su*	*mg SU*	*mg SU*	27
2	*MG su*	*MG su*	*mg SU*	*mg* su^L	2
3	*MG su*	*MG su*	*mg SU*	*MG SU*	2
4	*MG su*	*mg su*	*mg SU*	*mg*^{L} *SU*	1
5	*MG su*	*MG SU*	*mg SU*	*mg SU*	1

It is inferred from these observations that the genes *MG* and *SU* are on the same chromosome; but since neither shows linkage with *MA*, both are more than 50 morgans from the latter.

Discussion. These observations indicate that the genes *MA*, *MZ*, *MG* and *SU* are on the same chromosome. All the substrates except one carry exposed (terminal) alpha-glucosidic linkages: maltose, alpha-methyl glucoside, melezitose, turanose, and sucrose. The exception is raffinose. The genes *MA*, *MZ* and *MG* cannot produce an enzyme capable of action on raffinose. *SU* produces a beta-fructo-furanosidase which hydrolyses both sucrose and raffinose (but not maltose)[5,6].

The high frequency of recombination between these loci does not indicate that the absolute distances between them are great. A single chiasma in each region at each meiosis would produce completely free assortment. No other loci linked to these genes have been found, and it seems difficult to escape the conclusion that their proximity to each other indicates a common origin.

Two other carbohydrases, galactokinase and melibiase, under the control of the genes *GA* and *ME*, are also linked. (The gene *GA* was formerly termed *G*; a two-letter symbolism for all genotypes has been adopted. Three-letter symbols indicate phenotypes.) Their linkage was revealed by recombination[4] and confirmed by the location of another gene for red pigment (*AD*$_3$) between them[7]. The fact that one gene controls an enzyme acting on galactose whereas the other acts on a molecule containing galactose suggests that they may have a common origin. *GA* controls the transformation of galactose into a utilizable hexose; *ME* controls the hydrolysis of melibiose into glucose and galactose.

The specially selected non-fermenting clones which were used to build up the Carbondale stock are distinguished from the fermenters by complete inability to ferment or utilize the specified carbohydrate.

These selected recessive stocks are completely without the enzyme necessary to effect utilization of the carbohydrate and are completely incapable of producing it by adaptation. Selection of the non-fermenter stocks has required an extensive, critical survey of a large variety of yeasts. In contrast with these unique, completely negative cultures, cultures are available which are genetically differentiated with regard to utilization of a specific carbohydrate by using it less rapidly than the fully potent culture. There are thus two strikingly different types of genic differentiation of *Saccharomyces* cultures in ability to utilize or ferment carbohydrates: one is unique and involves complete inability either to produce the specific enzyme or to adapt itself to the substrate; the other involves diminution in the ability to ferment the substrate due to a gene-controlled biochemical defect. Two cultures, both carrying the dominant gene controlling the fermentation of galactose, have been differentiated into strong and weak fermenters by such a gene, and segregation of strong versus weak fermentation of galactose has been demonstrated in such a system (Dr. Herschel Roman, personal communication). If defects were present which brought about the absence of specific co-enzymes, a hybrid might show regular segregation for strong versus weak fermentation of maltose and simultaneously show a regular segregation for strong versus weak fermentation of galactose. If more than one enzyme system were involved in the utilization of a single carbohydrate, as has been demonstrated by Leloir and his associates[8] for galactose, more than one gene-pair might be demonstrated controlling strong versus weak fermentation of that carbohydrate. In contrast to this condition, a gene resulting in the complete inability to produce a carbohydrate is inferred to involve the unique gene directly concerned with the formation of the enzyme itself—a gene which might be called the *enzyme-template* gene.

On the basis of this discussion, the genes *MA*, *MZ*, *MG* and *SU* (as well as *GA* and *ME*) are identified as enzyme-template genes. Evidence has been presented[6,9] showing that the action of several of these genes is inhibited by the presence of similar substrates, or by the by-products of hydrolysis, suggesting that the gene functions by direct contact of the gene-surface with the substrate, and it is this contact with a topographically specific surface which induces the adaptation. The proximity of the genes *MA*, *MZ*, *MG* and *SU* suggests that they have a common origin and that their number has been increased by unequal crossing-over and mutation of the 'extra' gene[10]. One may assume that *Saccharomyces* originally possessed only a glycolytic system and was incapable of hydrolysing saccharides. That the original novelty with regard to alpha-glucosides comprised either *MA* or *SU* may be inferred from the fact that ability to ferment alpha-methyl glucoside is relatively rare and ability to ferment melezitose is even more unusual. The ability to act on galactose and galactosides is a similar relatively recent novelty. It may be assumed that *GA* was the original novelty, since the ability to act on melibiose is not widespread, and that duplication of the *GA* locus led to transformation of the 'extra' *GA* into the *ME* locus. It has already been suggested[4], on the basis of the mutual exclusion in *Saccharomyces* of ability to ferment maltose and lactose, that the capacity to ferment lactose has its origin in the transformation of the *MA* locus to a locus controlling the capacity for lactose fermentation.

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A NEW METHOD FOR ACETYLATING PROTEINS

By Drs. J. BADDILEY, R. A. KEKWICK and E. M. THAIN

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RECENT studies by two of us on the chemistry of coenzyme A necessitated the preparation and examination of several acetylthiols[1]. These were required as models to establish a chemical basis for the suggestion that coenzyme A effects acetylations by acetyl transfer at its terminal SH group[2]. The simple acetylthiols were found to be quite effective acetylating agents towards amines in aqueous or alcoholic solution. It appears that acetylthiols in general are capable of acetylating amino compounds, and Wieland and his collaborators[3] have developed a method of peptide synthesis which involves the interaction of such compounds with the amino group of an amino-acid. Alcoholic and phenolic hydroxyl groups are unaffected by these reagents.

The ease with which some of these acetyl derivates reacted towards amines suggested to us their possible use in acetylating amino groups in proteins. The preparation of partially acetylated proteins is of considerable interest in relation to the possible modification of the specific biological activity of enzymes, toxins and hormones, the effect on the immunological specificity of proteins in general and also in connexion with structural investigations. Previously, acetylation was carried out with acetic anhydride, usually in dilute acid solution, or with ketene[4,5]. These reagents are, by their nature, rather unspecific with regard to the group or groups attacked, and the experimental conditions employed leave not a little to be desired, since proteins are often highly sensitive to small changes in their environment and chemical reagents may easily effect deep-seated structural alterations. The acetylation technique described in this article does not suffer from these disadvantages and is, we believe, highly selective.

The substance 2′acetylthioethylacetamide, $CH_3CO.NH.CH_2CH_2S.CO.CH_3$, was chosen for these investigations since it is readily soluble in water, is stable towards dilute acids and alkalis, and acetylates amines quite effectively. Approximate reaction con-

ditions were determined by studying its action on simple amino-acids. An almost quantitative yield of acetylglycine was obtained when the reagent (*c.* 2 mol.) was added to a 10 per cent solution of the sodium salt of glycine (1 mol.) and the resulting solution kept for 12 hr. at 37°. In a similar experiment with alanine, reaction was only complete after three to four days at 37°.

It was thought that conditions should be chosen to ensure that a reasonable proportion of the amino groups in the substance to be acetylated was in the $-NH_2$ form, as distinct from $-NH_3^+$, in order that the reaction might proceed. Since in proteins the ω-amino group of lysine has a pK value of about 10·5, the earlier experiments were performed in a borate buffer at *p*H 10.

Human serum albumin isolated by the use of solvents at low temperature[6] was available to us as a protein of established purity (Fig. 1*a*). A 2 per cent solution in borate buffer at *p*H 10·0, to which had been added 2′acetylthioethylacetamide (to 1·5 per cent) was kept at room temperature during three days, then dialysed exhaustively against phosphate buffer (*p*H 8, $I = 0{\cdot}2$) at 2° for examination in the ultra-centrifuge and electrophoresis apparatus. It was expected that the ω-amino groups of the lysine residues and the end α-amino groups in the protein would be acetylated by this treatment.

On electrophoretic examination at *p*H 8, the product showed two components (Fig. 1*b*), both of which had a mobility considerably greater than that of the untreated protein.

The increase in mobility is consistent with the acetylation of amino groups and consequent increase in net negative charge. In the ultracentrifuge also two components were observed (Fig. 1*b*), a main component sedimenting at approximately the same speed as untreated serum albumin and another component sedimenting more rapidly.

It was considered that the heavy component might have arisen through the reduction of some intramolecular disulphide bonds by the free thiol (2′-mercaptoethylacetamide) derived from the acetylating reagent, the protein —SH groups liberated afterwards reoxidizing to form intermolecular disulphide bonds leading to an increase in molecular weight. Such an

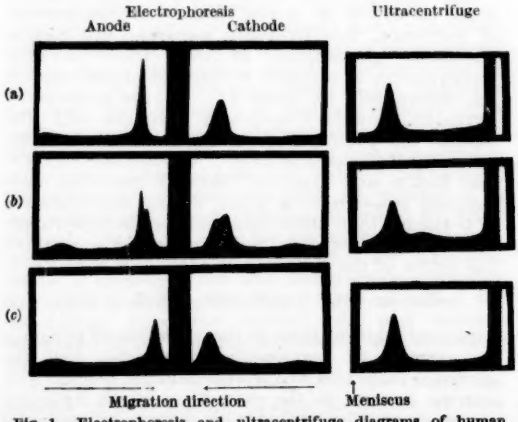

Fig. 1. Electrophoresis and ultracentrifuge diagrams of human serum albumin. (*a*) Untreated; (*b*) Acetylated in deep solution at *p*H 10; (*c*) acetylated in thin film under oxygen at *p*H 10. Migration times at 15 m.amp. (*a*) 178 min., (*b*) 98 min., (*c*) 113 min. Ultracentrifuge photographs all after 60 min. at 54,000 r.p.m.

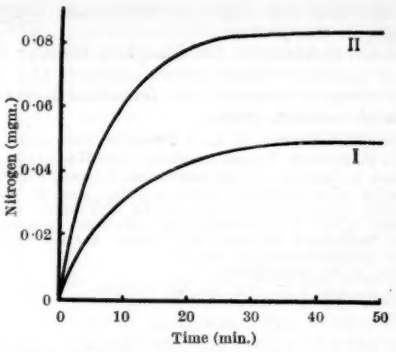

Fig. 2. Van Slyke estimation of amino-nitrogen on 5·25 mgm. samples of acetylated (I) and unacetylated (II) human serum albumin with increasing time of reaction with nitrous acid.

explanation was made more probable by the observation that the addition of 2-mercaptoethylamine to a solution of serum albumin under the same conditions resulted in the formation of some faster-sedimenting material and the appearance of two electrophoretic components but without an increased mobility.

A preparation homogeneous both in the ultracentrifuge and the electrophoresis apparatus (Fig. 1*c*) was obtained by spreading the solution of reactants in a film approximately 2 mm. deep under oxygen to ensure that any thiol produced from the acetylating reagent was rapidly oxidized to innocuous disulphide.

The mobility of the single component was 2·1 times that of untreated serum albumin. Furthermore, determination of the free amino groups by the method of Van Slyke indicated that about 34–39 amino groups/mole (70,000) had been acetylated (Fig. 2).

Repetition of this acetylation procedure on the once-treated albumin resulted in no further reduction of amino-nitrogen, as estimated by the Van Slyke method, and the electrophoretic mobilities of the once- and twice-acetylated albumin were identical. This indicates that the single treatment was sufficient to affect the acetylation of all the groups capable of reaction under the experimental conditions.

A further acetylation experiment using the thin-film procedure but at *p*H 8·5 again gave a product homogeneous in the ultracentrifuge and electrophoresis apparatus. In this instance the electrophoretic mobility of the product at *p*H 8 was 1·45 times that of untreated albumin, and Van Slyke measurements indicated that some 16–17 amino groups/mole had been acetylated.

It would appear from these results that the number of groups acetylated in the molecule is to some degree dependent on the *p*H of the reaction mixture, and also, in view of the electrophoretic homogeneity, that all the molecules are acetylated to about the same extent under specified conditions.

The nitrogen liberated from native serum albumin by the Van Slyke procedure was equivalent to 64 amino groups/mole, which is close to the value of 68 given by Brand[7]. After exhaustive acetylation at *p*H 10 the product still appears to have 25–30 free amino groups/mole. This would appear to imply that, of the fifty-nine lysine residues present in the molecule[7], about half are inaccessible to acetylation under the conditions of reaction employed, assuming that all end α-amino groups, which from the data of Brand[7] amount to 9 groups/mole, are acetylated. A higher reaction *p*H has not so far been studied, as it

was felt that this might of itself cause irreversible changes in the protein.

We are indebted to Dr. Margaret Mackay for the gift of purified human serum albumin and to the Department of Scientific and Industrial Research for a special research grant.

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ROLE OF SULPHYDRYL GROUPS IN THE OXIDATION OF PYRUVATE

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THE important part played by sulphydryl groups in the oxidation of pyruvate by tissue preparations was established by the work of Peters[1] and Barron[2] and their colleagues. Recently, two essential co-factors required for this oxidation, coenzyme A[3] and α-lipoic acid[4], have been found to contain sulphydryl groups, and Lynen and Reichert[5] have found that this grouping in coenzyme A is concerned in its transacetylation reactions. This prompted Lynen and Reichert to suggest that in the oxidation of pyruvate by pyruvic dehydrogenase, pyruvate or an acetaldehyde derivative formed by the decarboxylation of pyruvate actually combined with the sulphydryl group to form a compound which was oxidatively decarboxylated to acetyl-coenzyme A and carbon dioxide thus (*R*.SH = coenzyme A):

$$\mathrm{CH_3.C(=O).COOH} + R.\mathrm{SH} \rightarrow \mathrm{CH_3.C(OH).COOH(SR)} \xrightarrow{-2H} \mathrm{CH_3.C(=O)(SR)} + \mathrm{CO_2} \quad (1)$$

$$\text{or} \quad \mathrm{CH_3.C(=O).H} + R.\mathrm{SH} \rightarrow \mathrm{CH_3.C(OH)(SR).H} \xrightarrow{-2H} \mathrm{CH_3.C(=O)(SR)} \quad (2)$$

This is similar to mechanisms proposed for the function of glutathione in the glyoxalase system[6,7] and in the oxidation of glyceraldehyde by cozymase and glyceraldehydephosphate dehydrogenase[7].

Korkes, Del Campillo, Gunsalus and Ochoa[8] agree with Lynen and Reichert's mechanism and bring forward in its support the experiments of Cavallini[9] on the coupled oxidation of pyruvate in the presence of glutathione (GSH) as a chemical model for the enzymic reaction. Cavallini found that, in the presence of pyruvate, the oxygen uptake exceeded that calculated for the equation:

$$2\,\mathrm{GSH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O}, \quad (3)$$

and carbon dioxide was produced in accordance with the oxidative decarboxylation of pyruvate to acetate and carbon dioxide:

$$\mathrm{CH_3.CO.COOH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{CH_3.COOH} + \mathrm{CO_2}. \quad (4)$$

He proposed that an intermediate complex was formed which was oxidized thus:

$$\mathrm{CH_3.C(=O).COOH} + \mathrm{GSH} \rightarrow \mathrm{CH_3.C(OH)(SG).COOH} \quad (5)$$

$$2\,\mathrm{CH_3.C(OH)(SG).COOH} + 3\,\mathrm{O} \rightarrow \mathrm{GSSG} + 2\,\mathrm{CH_3.COOH} + 2\,\mathrm{CO_2} + \mathrm{I} \quad (5a)$$

or

$$\mathrm{CH_3.C(OH)(SG).COOH} + \mathrm{GSH} + \mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O}. \quad (5b)$$

In the light of experiments I have carried out on the copper-catalysed oxidation of 2 : 3 dimercaptopropanol[10], it appeared likely that an alternative mechanism not involving compound-formation between pyruvate and glutathione would explain Cavallini's experiments. The alternative mechanism is described by the following equations:

$$2\,\mathrm{GSH} + \mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O_2} \quad (7)$$

$$2\,\mathrm{GSH} + \mathrm{H_2O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O} \quad (8a)$$

$$2\,\mathrm{GSH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{GSSG} + \tfrac{1}{2}\,\mathrm{H_2O} \quad (7 + 8a)$$

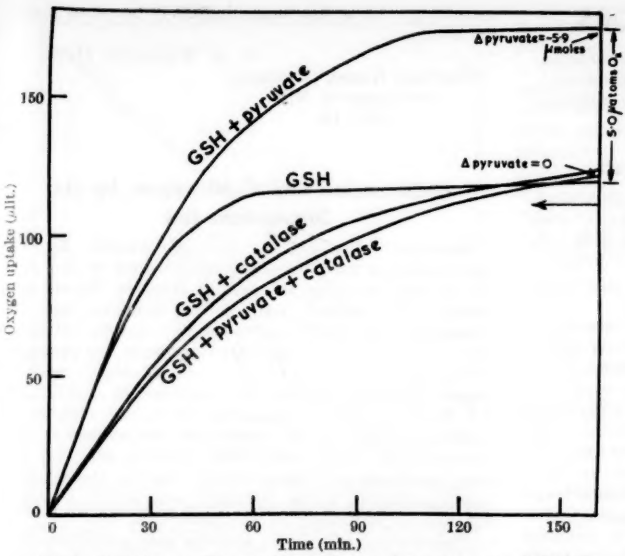
$$\mathrm{CH_3.CO.COOH} + \mathrm{H_2O_2} \rightarrow \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O} \quad (8b)$$

$$2\,\mathrm{GSH} + \mathrm{O_2} + \mathrm{CH_3.CO.COOH} \rightarrow \mathrm{GSSG} + \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O}. \quad (7 + 8b)$$

Hydrogen peroxide is invariably formed in oxidations catalysed by cupric ions. In the absence of pyruvate, this hydrogen peroxide will oxidize additional glutathione, so that there is little accumulation of peroxide at the end of the reaction (cf. Slater, ref. 10, Table 6). In the presence of pyruvate, however, hydrogen peroxide will also oxidize the pyruvate, according to a reaction first shown by Hollemann in 1904[11]. Negelein and Brömel[12] and Keilin and Hartree[13] showed that this non-enzymic reaction took place during the oxidation of D-alanine by D-amino-acid oxidase, both pyruvate and hydrogen peroxide being formed as a result of the action of the enzyme:

$$\text{D-alanine} + \mathrm{O_2} \rightarrow \text{pyruvate} + \mathrm{NH_3} + \mathrm{H_2O_2}. \quad (9)$$

Lipmann[14] showed that, in the oxidation of pyruvate by extracts of *Lactobacillus delbrueckii*, half the pyruvate molecules which were oxidized reacted with enzyme systems in the extract, in which hydrogen atoms eventually reacted with oxygen by means of an autoxidizable flavoprotein, while the remaining half were oxidized non-enzymically by the hydrogen peroxide produced in this autoxidation of the flavine.



Effect of catalase on the coupled oxidation of pyruvate and glutathione

The mechanism proposed in equations (7)–(8) was tested by determining the effect of catalase, which would be expected to have the following effects:

(*a*) Since the hydrogen peroxide produced by reaction (7) would be decomposed by the catalase, thereby liberating oxygen instead of oxidizing glutathione, the initial rate of the net oxygen uptake should be halved by the addition of catalase. In the absence of pyruvate, the final oxygen uptake should not be affected, since either in the presence or absence of catalase, oxygen is reduced to water, not hydrogen peroxide.

(*b*) In the presence of catalase, pyruvate should have no effect on the oxygen uptake, nor should any pyruvate disappear.

The accompanying graph shows the effect of catalase on the coupled oxidation of pyruvate and glutathione. All flasks contained glutathione, cupric chloride and phosphate buffer exactly in the quantities specified by Cavallini[9]; temperature, 38° C. Catalase (0·2 mgm. pure catalase) and/or pyruvate (20 μmoles) was added as indicated. The horizontal arrow shows the oxygen uptake corresponding to equation (3). Δ pyruvate refers to the difference between the contents of reaction vessels after 160 min. and controls incubated without glutathione. The pyruvate was determined spectrophotometrically with lactic dehydrogenase and reduced cozymase[15]. The graph shows that the effect of catalase is in accordance with the mechanism described by equations (7) and (8). In the presence of catalase, there is a slow oxygen uptake after the calculated value is exceeded, but this side-reaction (probably involving oxidized glutathione) does not affect the conclusion, since the curves with and without pyruvate, in the presence of catalase, are very close together.

In the absence of catalase, pyruvate caused the uptake of 5·0 μatoms oxygen in excess of that obtained without pyruvate, and this was accompanied by the disappearance of 5·9 μmoles pyruvate, in good agreement with equation (4). These figures show that, under the conditions of this experiment, approximately half the hydrogen peroxide produced by reaction (7) reacted with glutathione (reaction 8*a*) and half with pyruvate (reaction 8*b*).

The effect of catalase clearly shows that hydrogen peroxide is involved and is strong support for the mechanism proposed, which is, moreover, in accord with well-known reactions. Cavallini's mechanism does not explain the effect of catalase. The mechanism now suggested has the further advantage that it explains Cavallini's earlier experiments[16] in which ascorbic acid was also found to promote the oxidative decarboxylation of pyruvate. The explanation is undoubtedly the same as for the action of glutathione, since hydrogen peroxide is also produced during the copper-catalysed oxidation of ascorbic acid. Indeed, this was the explanation proposed by Cavallini[16] to describe the effect of ascorbic acid.

Since pyruvate is certainly oxidized in animal tissues by the cytochrome system, hydrogen peroxide will not be formed. Thus, there can be little resemblance between the coupled oxidation of pyruvate by glutathione *in vitro* and the oxidation of pyruvate *in vivo*. Cavallini's experiments cannot, then, be considered a satisfactory model of the enzyme. This does not, of course, necessarily mean that the mechanism proposed by Lynen and Reichert and by Korkes *et al.* is incorrect. But it does direct attention to the fact that evidence other than that provided by Cavallini's 'model' experiments must be found. In the case of the glyoxalase reaction, Racker[7] has obtained more direct evidence, since he found that the function of one of the two enzymes in the system is to promote the formation of a compound between methylglyoxal and glutathione. This compound was identified spectrophotometrically and found to be the substrate for the second enzyme of the system. In the present study, spectrophotometric measurements in the ultra-violet region gave no evidence of the formation of a compound between pyruvate and glutathione, under the conditions of Cavallini's experiments.

I wish to thank Prof. D. Keilin for his advice and the Agricultural Research Council for a personal grant. [Aug. 19.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Secrecy and Industrial Research

In his presidential address to the British Association, on "The Ethical Dilemma of Science", Prof. A. V. Hill referred to the problem of secrecy in relation to the results of industrial research. I believe that the difficulty arises from confusion of technology with science.

These two fields of human endeavour are really quite distinct. Technology is the art of making things. It deals with the methods used for production. In this sense, even animals practise technology, and the evolution of men and the growth of civilization have depended upon the advance of technology. Technology advances by trial and error and by specific inventions. Much of the advance of technology is empirical, and, as Dr. J. B. Conant says, it is by the application of science to technology that the degree of empiricism in technology is reduced. Thus, when we speak of applied science, we mean science applied to technology. In industrial laboratories, the primary purpose of the laboratory is to advance technology, and, in order to do this, scientific work is undertaken so that the scientific results can be applied to advance the technology and reduce its empiricism.

This distinction between the technological work and the scientific work of an industry suggests a policy for the publication of new results. This is that industrial companies should publish their scientific work, but are under no obligation to publish their technological advances.

Scientific advances must be published even when they are applicable to technology because science advances as a whole, and any attempt to withhold the publication of scientific work reacts to the disadvantage of the withholder. Moreover, scientific men will not continue to do satisfactory work unless they can publish that work and feel they are taking part in the advancement of science. The great advance in applied science in the past fifty years is undoubtedly due to the general publication of scientific work done in industry as well as in the universities.

In my opinion, on the other hand, an industrial company is under no obligation to publish information as to its manufacturing technology. Publication is of value only to other firms who use that particular technology. In practice, however, it is impossible to keep technological methods secret for a long time. Often it is necessary to obtain the protection of patents, since otherwise a patent may be obtained by someone else, and a firm that has been using a secret process may find itself unable to use the process. To avoid this difficulty, firms often take out patents even though they desire no monopoly, and thus a great deal of technology is published which would otherwise remain secret.

Technical advances are also often published for purposes of prestige. Sometimes they are published because the applied science cannot be made known without publishing information as to the technology. Holding a technological process secret, therefore, merely delays the publication, and eventually the technology of a few years before it becomes public knowledge.

C. E. Kenneth Mees

Eastman Kodak Company,
Rochester 4, N.Y.
Oct. 14.

N-Nitration and *C*-Nitration by the Nitronium Ion

Aromatic *C*-nitration through attack by the nitronium ion was kinetically established by the work of Benford and Ingold[1], and of Hughes, Ingold and Reed[2]. The central point in the evidence was the observation of zeroth-order kinetics in the nitration of suitably reactive aromatic compounds, for example, of toluene, by a constant excess of nitric acid, in organic solvents such as nitromethane or acetic acid. All those aromatic compounds which are sufficiently reactive to take up the nitronium ion as fast as it is formed from nitric acid obey this law, and, for the same medium and temperature, can be observed to become nitrated at an identical rate, which is simply the rate of formation of the nitronium ion.

The zeroth-order form, and the associated absolute reaction-rate, constitute, therefore, a highly diagnostic test for the intervention of the nitronium ion in any reaction in which it is consumed as fast as it is formed. Thus the *N*-nitration of a secondary amine or the *O*-nitration of an alcohol, supposing the amine or the alcohol to be reactive enough, must, if the substituting agent is indeed the nitronium ion, be observable as zeroth-order reactions, having, in fixed conditions, rates identical with each other, and with the rate of nitration, say, of toluene.

We have used this criterion in order to show that the formation of nitroamines from secondary amines, and the formation of alkyl nitrates from alcohols by the action of nitric acid, involve attack by the nitronium ion on the nitrogen or oxygen atom. All kinetic measurements were made by the dilatometric method, controlled by chemical analysis. The course of the conversion of N-methyl : 2 : 4 : 6-trinitroaniline ('methylpicramide') into N-methyl-N : 2 : 4 : 6-tetranitroaniline ('tetryl') by 4 *M* nitric acid in nitromethane at 25° is illustrated in Fig. 1. This *N*-nitration is evidently a zeroth-order reaction. The con-

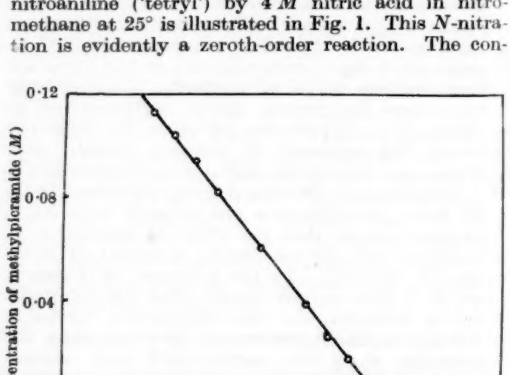

Fig. 1. Nitration of methylpicramide by 3·95 *M* nitric acid in nitromethane at 24·9°

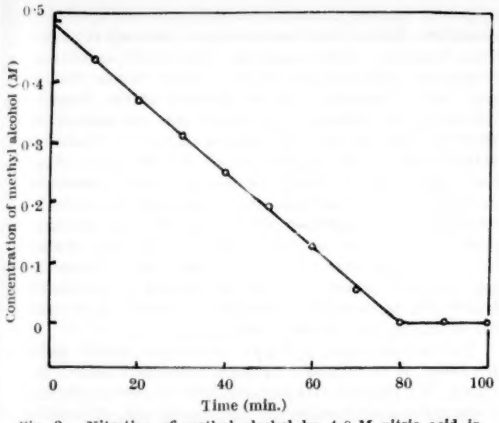

Fig. 2. Nitration of methyl alcohol by 4·0 *M* nitric acid in nitromethane at 24·9°

version of N-methyl : 2 : 4-dinitroaniline into N-methyl-N : 2 : 4-trinitroaniline proceeds in the same way at the same rate, though the product additionally takes up a *C*-nitro-group in a subsequent much slower reaction of first order, leading to tetryl. The conversion of methyl alcohol into methyl nitrate in similar conditions is likewise a reaction of order zero, as illustrated in Fig. 2. The absolute rate of any of these *N*- and *O*-nitrations is just the same as that of the *C*-nitration of any benzene derivative which uses the zeroth-order form of reaction, as has been shown by direct comparisons under several sets of conditions. Such a comparison with toluene is illustrated in Table 1.

Table 1. Comparison of Zeroth-Order Rates of *C*-, *N*-, and *O*-Nitration by 4·0 *M* Nitric Acid in Nitromethane at 24·9°, with $[HNO_3] = 0{\cdot}0076 \pm 0{\cdot}0001$ *M* (Unchanged by Nitration) Throughout

Substance nitrated	Initial conc.	Rate (mole. $l.^{-1}$ $sec.^{-1}$)
Toluene	0·699 *M*	$10{\cdot}3 \times 10^{-7}$
Methylpicramide	0·119 ,,	$10{\cdot}4$,,
Methyl alcohol	0·491 ,,	$10{\cdot}2$,,

We know that in *C*-nitration by the nitronium ion, only the more reactive aromatic compounds, such as toluene and benzene, take up the ion as fast as it is produced, and thus exhibit nitration in zeroth-order form. Less reactive aromatic compounds, such as chlorobenzene, take up the nitronium ion less quickly than it is produced, and the absolute rate of nitration is accordingly smaller, while the kinetics now approach first-order form. Similar changes in rate and order are to be expected for *N*- and *O*-nitration, where there is an appropriate suppression of reactivity towards the substituting agent. As illustration, neopentyl alcohol undergoes *O*-nitration by nitric acid in nitromethane much more slowly than does methyl alcohol. Furthermore, the reaction of neopentyl alcohol is approximately of first-order form, and, as is shown in Table 2, the absolute rate is comparable to that of the nitration of chlorobenzene, likewise a reaction of approximately first order, under the same conditions.

Table 2. First-Order Rates of *C*-Nitration of Chlorobenzene and of *O*-Nitration of Neopentyl Alcohol by 3·77 *M* Nitric Acid in Nitromethane at 24·9°

Substance nitrated	Initial conc.	Rate constant ($sec.^{-1}$)
Chlorobenzene	0·178 *M*	$5{\cdot}53 \times 10^{-4}$
Neopentyl alcohol	0·176 ,,	$4{\cdot}22$,,

The *O*-nitration of glycerol and of cellulose is indirectly shown by such model experiments to involve attack on oxygen by the nitronium ion. [2]A direct analysis of the reaction in these cases is complicated by reason of the number of successive steps involved, but progress is being made with the kinetics of nitration of some of the simpler polyhydric alcohols, including glycerol.

We wish to record our appreciation of the interest and help of Prof. C. K. Ingold.

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[1] *J. Chem. Soc.*, 929 (1938).
[2] *Nature*, **158**, 448 (1946); *J. Chem. Soc.*, 2400 (1950).

Role of Water in the Structure of Psilomelane, $(Ba,H_2O)_2Mn_5O_{10}$

A specimen of psilomelane (*BM*.69,160) from Schneeberg, Saxony, was kindly made available for examination by the Department of Mineralogy, British Museum (Natural History). This material forms minute monoclinic crystals with $a = 9{\cdot}56$, $b = 2{\cdot}88$, $c = 13{\cdot}85$ A., $\beta = 92°\ 30'$, probable space group $A\ 2/m$. These values are a refinement of those previously reported by Vaux[1]. The unit cell contains two empirical formula units, $Ba_{0{\cdot}64}(Mn,R)_5O_{10}{\cdot}1{\cdot}36\ H_2O$, giving $d_{calc.} = 4{\cdot}82$, $d_{obs.} = 4{\cdot}71$; the ions *R* comprise Mn^{3+} and traces of other metals substituted for Mn^{4+}.

The structure, determined by Fourier methods, is based upon double and treble strings of manganese-oxygen octahedra linked in an approximately rectangular grouping by sharing corners to form tunnels parallel to the *b*-axis (Fig. 1). These enclose barium ions and water molecules which are crystallographic-

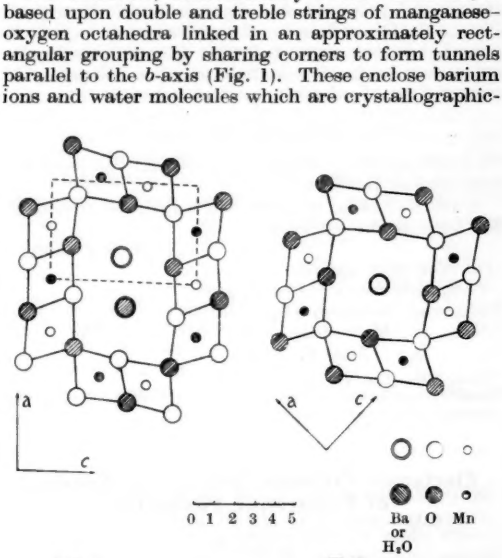


Fig. 1 Fig 2

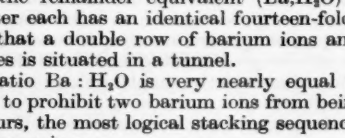
Fig. 1. Structure of psilomelane projected on the *b*-axis. The broken lines enclose an area $\frac{1}{2}a \times \frac{1}{2}c$

Fig. 2. Structure of hollandite projected on the *b* (monoclinic)-axis

In each figure, open circles denote atoms at $y = 0$, shaded circles atoms at $y = \frac{1}{2}$

ally indistinguishable. Each of these is situated at the centre of fourteen ions or molecules, the ten approximately equidistant near-neighbours forming the corners of a prism and pyramid. Six are oxygen atoms, the remainder equivalent (Ba,H_2O) groups. The latter each has an identical fourteen-fold grouping, so that a double row of barium ions and water molecules is situated in a tunnel.

The ratio $Ba : H_2O$ is very nearly equal to 1 : 2. In order to prohibit two barium ions from being near-neighbours, the most logical stacking sequence in the double rows is :



There is no diffraction evidence to support this view, despite a sufficient difference between the scattering-power of two molecules of water and of one barium ion to demonstrate such a grouping if it existed. Nevertheless, this arrangement is the only one which is feasible on electrostatic grounds, and the double rows of (Ba,H_2O) units, therefore, are probably disordered with respect to one another.

The dehydration of psilomelane, which resembles that of the zeolites, is accompanied by a phase transition to hollandite (Fig. 2) when most of the water is removed. It is evident that too many vacant sites are created in the double row for structural stability, and the collapse to hollandite is effected by the rearrangement of treble strings of octahedra into double strings, and the double row of barium ions into a single row.

Despite the smaller unit cell of hollandite, there are insufficient barium ions to fill all the sites in a single row. The formula of hollandite, deduced from that of the psilomelane used in this investigation, is $Ba_{1\cdot01}(Mn,R)_8O_{16}$, in good agreement with that previously proposed by Byström and Byström[2], $Ba_{(2-x)}Mn_8O_{16}$, where x is approximately equal to one. It has been suggested[3] that discrete water molecules may be present in hollandite as occupants of vacant sites of otherwise perfect sub-rows :

—vac.—Ba—vac.—Ba—vac., etc.

This speculation receives support from the proposed structure of psilomelane.

A more detailed account will shortly be presented for publication elsewhere.

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[1] Vaux, *Min. Mag.*, **24**, 521 (1937).
[2] Byström and Byström, *Acta Cryst.*, **3**, 146 (1950).
[3] Byström and Byström, *Acta Cryst.*, **4**, 469 (1951).

Electronic Orbitals, Shapes and Spectra of Polyatomic Molecules

Our ideas and knowledge of the shapes of polyatomic molecules are largely confined to the ground electronic states. Comparatively little progress has been made in knowledge of the symmetries of electronically excited states. Not infrequently it has been tacitly, but unjustifiably, assumed that the excited state of a molecule has the same symmetry as the ground-state. Bound up with this, spectroscopists, having made a vibrational analysis of a spectrum, have often been content to leave it at that; they have not tried to answer the question as to why particular vibrations occur. There have been exceptions, of course—the occurrence of the breathing vibration of benzene on electronic excitation near 2600 A. has been, for example, very reasonably attributed to an expansion of the benzene ring in the upper state—but, especially with non-totally symmetrical vibrations, it is usually true that no explanation has been offered for the occurrence of particular modes of vibration. Why, for example, do e_g^+ vibrations occur in the near ultra-violet spectrum of benzene ? That these enable an otherwise forbidden transition to become allowed is, of course, no explanation of why they occur.

For some time I have been interested in this problem of the shapes of electronically excited molecules. My procedure has been first to decide the molecular orbitals possible for two particular shapes of a particular molecule ; then to decide which orbital of the one symmetry class must transform to a particular orbital of the other symmetry class when some parameter is varied from its value for one shape to its value for the other ; and finally to decide whether a particular orbital becomes more or less tightly bound as that parameter is varied. The resulting correlation diagram is of great value, for it implies what will be the most stable shape for any electron configuration (including the ground-state) ; and hence what vibrations are likely to be aroused in a particular electronic transition and whether the maximum intensity will be close to or far from the origin of the system ; what will be the formulation of the longest wave-length transitions and hence whether these transitions will be allowed or forbidden ; and, if the former, how they will be polarized. This procedure has been applied first to triatomic molecules (AH_2, AB_2, BAC, HAB molecules) ; then to tetratomic molecules (AH_3, AB_3, H_2AB, B_2AC molecules) ; then to the methyl halide molecules ; then to ethylene and more complicated molecules. A brief verbal account of the work was given to the International Conference of Spectroscopists at Basle in June 1951 [1], and a full account is now being submitted for publication elsewhere. In this communication, I wish to summarize some of the outstanding results. Some of them have been obtained before, but not as part of a comprehensive treatment.

(1) AH_2 molecules containing 4 valency electrons should be linear in their ground-states. Those containing 5, 6, 7 or 8 electrons should be bent in their ground-states. The first excited states of 4-electron AH_2 molecules should be bent.

(2) Non-hydride triatomic molecules containing 16 valency electrons should be linear in their ground-states. 17, 18, 19, 20-electron molecules should be bent, the apex angle decreasing with increase in number of electrons. The first excited states of 16-electron molecules should be bent.

(3) HAB molecules containing 10 valency electrons should be linear in their ground-states. Molecules with more than 10 electrons should be bent in their ground-states. The first excited state of HCN should be bent. The first excited state of C_2H_2, which is *iso*-electronic with HCN, should be non-linear.

(4) AH_3 molecules containing 6 valency electrons should be planar in their ground-states, pyramidal in their first excited states. AH_3 molecules containing more than 6 valency electrons should be pyramidal in their ground-states.

(5) AB_2 or B_2AC molecules containing 24 valency electrons should be planar in their ground-states, but pyramidal (if stable) in their first excited states. 25-, 26- and 28-electron molecules should be pyramidal in their ground-states, the BAB or BAC angle decreasing as the number of electrons increases.

(6) If X is the centre of the mid-point of the H—H line, the first excited state of the HCHO molecule should have the XCO line bent both in the molecular plane and out of that plane. The distortion is insufficient for the classification of the levels according to the C_{2v} symmetry operations to lose its importance, but sufficient to cause the $\nu_5 b_2$ and $\nu_6 b_1$ vibrations to appear in the spectrum. It has been possible to give a complete vibrational analysis of the fluorescence bands and make plausible assignments of the long-wave-length absorption bands.

(7) The first excited state of the C_2H_4 molecule should have: (*a*) one CH_2 group twisted through 90° relative to the other, (*b*) a pyramidal arrangement of the bonds about each carbon atom. The first excited state of a molecule containing n electrons should have the same symmetry as the ground-state of the similar molecule containing $n + 1$ or $n + 2$ electrons. It therefore becomes possible to confirm these statements concerning the first excited state of C_2H_4 by comparison with what is known of the ground-state symmetry of N_2H_4.

(8) The first Rydberg state of the CH_3I molecule should have: (*a*) a considerably decreased HCH angle, (*b*) the iodine atom off the trigonal axis of the CH_3 group. (*a*) causes the totally symmetrical CH_3 deformation vibration to appear in the spectrum; (*b*) causes the $\nu_6 e$ vibration to appear. (*a*) is particularly striking since the excitation is of an iodine electron which, superficially, one might have expected not to affect the CH_3 group.

(9) The C_6H_6 molecule should be distorted in its first excited states both in the molecular plane and out of that plane. The distortion is insufficient for the classification of the levels according to the D_{6h} symmetry operations to lose its importance, but sufficient to cause the appearance of a wide variety of in-plane and out-of-plane deformation vibrations.

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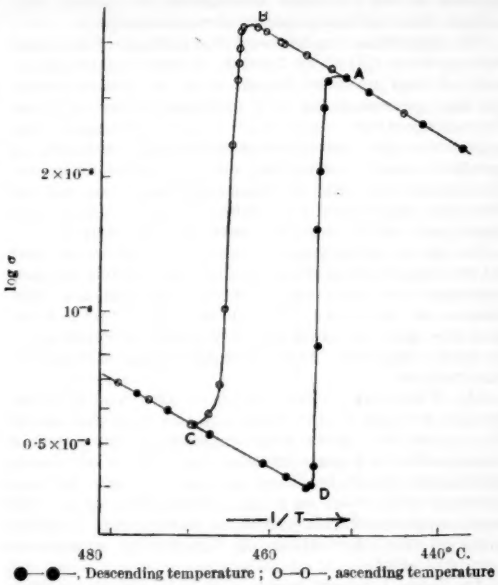
[1] See *Ang. Chem.*, **63**, 439 (1951).

Electrical Conductivity of Cæsium Chloride near the Thermal Transition

At normal temperatures, cæsium chloride is stable in a body-centred cubic lattice, and at higher temperatures in a simple face-centred lattice of the sodium chloride type. When single crystals were heated, it was found, using X-ray techniques, that a sharp transition occurred from one form to the other at 469°. Indications were, however, obtained that certain intensities of X-ray reflexions faded exceptionally rapidly on approaching the transition point[1]. This suggested that lattice defects of some kind might be increasing rapidly in number around the transition temperature. If these defects are of the type associated with ionic conductivity in crystals, a marked increase of electrical conductivity should be observed on passing through the transition point.



●—●, Descending temperature; O—O—, ascending temperature

Measurements have now been made of the conductivity of cæsium chloride crystals in the form of a polycrystalline mass chilled from the melt between two platinum electrodes. Instead of a rise, a steep drop in conductivity is observed on passing through the transition point. Marked hysteresis is observed around the transition; but above and below it the results are quite reproducible (see graph). The temperature coefficient of conductivity is found to be very approximately the same above and below the transition point, so that the steep drop in conductivity on passing to the high-temperature form must be due to the influence of crystal structure on the temperature-independent parameter σ_0 in the semi-empirical expression for the conductivity, $\log \sigma = \sigma_0 - E/kT$. It seems clear that if there is any pre-transition break-up of the lattice, it cannot be of the kind associated with the defects responsible for ionic conductivity. A similar drop in conductivity has been reported for thermal transitions[2] in mercuric iodide (137° C.) and potassium nitrate (128° C.).

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[1] Menary, Ubbelohde and Woodward, *Proc. Roy. Soc.*, A, **208**, 158 (1951).
[2] Jaffray, J., *C.R. Acad. Sci., Paris*, **230**, 525 (1950).

Paper Electromigration of Flavonoids and Sugars using a High Constant-voltage Current

All but a few[1] of the numerous reports in the past few years on the application of electromigration or electrophoresis on paper have used a comparatively low voltage. Recently, however, a method of paper electromigration which uses a high constant-voltage current has been developed in these laboratories and

appears to offer a more convenient and rapid procedure than ordinary paper chromatography.

The apparatus for delivery of a current of constant voltage from 100 V. to 1,000 V. is made by modification of that used by Heigl *et al.* as the constant-voltage generator for the photomultiplier of their Raman-spectrum apparatus[2]. In principle, the apparatus for determining migration distance is similar to that of Durrum, with, however, only one cabinet which contains the supporting glass rod for the filter paper and two vessels for electrolyte solutions into which carbon electrodes are dipped.

In use, a filter-paper strip 0·5–2 cm. wide and 40 cm. long is hung from the glass rod with both ends immersed in electrolyte. After applying the substance on the apex, current is passed for 2–4 hr. and the spots revealed by ultra-violet light (3650 A.) or spray reagents. The following examples illustrate the method.

(1) *Flavonoids.* The sample is dissolved in formamide, spotted on the centre of the strip and dried. To detect the spots after migration, the paper is immersed in a 5 per cent ethereal solution of lithium aluminium hydride, dried quickly by hot air, and sprayed with water or dilute hydrochloric acid. The spots appear reddish-yellow or dark green, possibly through the formation of lithium or aluminium complex salts.

In Table 1, where borax is used as the electrolyte, it is interesting to note the relation between the number of adjacent *cis*-hydroxyl groups of the sugar, or the number of vicinal dihydroxy groups of the aglycone, and the migration distance.

Table 1

Flavonoid	No. of adjacent *cis*-OH of sugar	No. of vicinal dihydroxy groups of aglycone	Migration distance to cathode (4 hr.) in mm.
Myricitrin	1	1	30
Rutin	1	1	25
Quercetin	0	1	16
Myricetin	0	1	10
Lutedin-7-glucoside	0	1	3
Naringin	0	1	3
Hesperidin	0	0	3
Acacetin	0	0	3
Morin	0	0	2
Robinin	0	0	2

Current: 500 V., 1·5 m.amp./cm. width. Paper: Toyo filter paper No. 50. Electrolyte: 2 per cent borax solution.

(2) *Sugars.* By application of high-voltage electromigration, all types of sugars may be separated, borax solution proving the best electrolyte (see Table 2).

Table 2

Sugar	Migration distance (4 hr.) in mm.		
	I	II	III
Fructose	+ 67	− 18	− 34
Glucose	+ 56	− 28	− 47
Sorbose	+ 46		− 50
Galactose	+ 84	− 18	− 52
Mannose	+ 21	− 15	− 55
Rhamnose	+ 3	− 22	− 45
Arabinose	+ 21	− 37	− 51
Ribo e	+ 57		
Xylose	− 63	− 19	− 46

I: Current 500 V., 1·6 m.amp./cm.; 1 per cent borax.
II: Current 650 V., 0·1 m.amp./cm.; 3 per cent boric acid.
III: Current 700 V., 0·2 m.amp./cm.; 1 per cent boric acid.
Paper: Toyo filter paper No. 50. Spray reagent: aniline hydrogen phthalate (cf. Partridge, ref. 3).

This work was described at the annual meeting of the Pharmaceutical Society of Japan, November 1951 and April 1952, at Osaka University. Thanks are due to Prof. T. Kariyone, of Kyoto University, and to Dean F. Seto of this College for guidance.

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[1] *J. Amer. Chem. Soc.*, **71**, 2942 (1950). Suzuki, T., and Maegawa, Y., *J. Pharm. Soc. Jap.*, **71**, 1298 (1951).
[2] *Anal. Chem.*, **22**, 154 (1950).
[3] *Nature*, **166**, 997 (1950).

Colorimetric Determination of Formaldehyde under Mild Conditions

In the course of work on the neutralization of formaldehyde in living bacterial cultures, it was found that the Hantzsch reaction between acetylacetone, ammonia and formaldehyde proceeded so readily at *p*H 6 that it afforded a good method of estimating microgram amounts of the latter. The yellow colour due to the formation of diacetyl-dihydro-lutidine is fully developed in two hours at room temperature, the molecular extinction being 8,000 at 412 mμ. The reaction will be fully described elsewhere; but a suitable reagent is known to be *M*/20 acetylacetone and *M*/30 acetic acid in molar aqueous ammonium acetate. The only unexpected interfering substance found was sulphite.

Detailed accounts of this work will be submitted elsewhere.

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A Substance in Animal Tissues which stimulates Ketone-Body Excretion

It has been known for many years that the glycosuria of clinical diabetes can be prevented by feeding a very high fat diet. Petren[1] showed that if the fat content of the diet was sufficiently great and if the protein content was restricted, the ketosis of diabetes could likewise be abolished. This observation was confirmed by Marks and Young[2] in dogs rendered permanently diabetic by the injection of anterior pituitary extract. They showed not only that a diet consisting entirely of beef suet produced a remission of diabetic glycosuria and ketonuria, but also that the addition of raw horse meat to such a diet caused an exacerbation of ketone body excretion. They were able to extract the factor in the horse meat responsible for the ketonuria and demonstrated that this material was not present in significant quantities in casein. Burn, Lewis and Kelsey[3] showed that alloxan-diabetic rats could be maintained without glycosuria on a high fat diet. Bornstein and Nelson[4] extended these observations and noted that alloxan-diabetic rats exhibiting ketonuria on moderately high fat diets ceased to excrete ketone bodies when the fat content of the diet exceeded 70 per cent. Lazaris and Brzezhinskaya[5] demon-

strated that the critical factor in the ketosis of diabetic rats on a high fat diet was the presence or absence of animal protein in the diet. When 'albumenous' material was added to the diet, ketosis ensued, whereas other dietary constituents had no ketogenic effect.

The present study has been devoted to the isolation and characterization of the substance in meat which produces ketonuria when administered to an animal on a high fat diet. Normal black-and-white male rats of the inbred laboratory strain and weighing approximately 180 gm. were placed on a diet consisting of margarine 70 per cent, protein 6 per cent, salt mixture 5 per cent and water 19 per cent, for a period long enough to produce a loss in weight equivalent to 35–40 per cent of the initial bodyweight. The diet was then reinforced with all the known B-vitamins. The precipitous fall in weight produced by the unsupplemented diet was arrested by the addition of B-vitamins and, thereafter, the animals maintained their weight or grew slightly. When the protein of the diet consisted of vitamin-free casein, the animals showed little or no ketonuria after 10–14 days on B-vitamins, while animals receiving a washed heat-coagulated dried horse-meat preparation showed a moderate to severe ketonuria (see accompanying table).

Diet	No. of determinations	Total ketone-body excretion* as mgm. acetone/24 hr.
70 per cent margarine + casein	21	0·45 ± 0·22
70 per cent margarine + horse meat	14	11·04 ± 5·25

* Determined by the method of Greenberg and Lester (ref. 6)

The stimulating effect of tissue extracts on ketone-body excretion can be tested in rats fed on the high fat diet containing casein as the protein constituent. Using this test as a rough guide, a fractionation of horse muscle has shown that the ketone-body stimulating substance present in horse muscle resides in the lipid portion and can be recovered chiefly from the mono-amino phosphatide fraction.

Fractional precipitation of *n*-butanol extracts of lyophilized horse muscle has yielded a preparation the properties of which are constant. The preparation is white, crystalline and possesses a sharp melting point (53°) which does not change on repeated remelting. A chloroform solution of the preparation is optically inactive, and the material is not subject to discoloration on prolonged exposure to air. Sodium fusion gives no evidence of nitrogen, phosphorus, sulphur or halogen, and an emission spectrum fails to demonstrate any significant metallic component. The material reacts with 2 : 4-dinitrophenylhydrazine and can be condensed with benzaldehyde to form a benzylidene derivative. It does not possess the reactions of an aldehyde and is therefore a ketone. The infra-red absorption spectrum (kindly prepared and interpreted by Dr. R. N. Haszeldine, of the Department of Chemistry) confirms chemical evidence suggesting the absence of other reactive groupings, and an absorption band at 5·73 μ supports the probability of a ketone structure. Elemental analysis (by Weiler and Strauss), C : 76·5, H : 12·8, O (by difference) : 10·6 per cent.

Lipid residues obtained from *n*-butanol extraction of calf intestinal mucosa kindly provided by Dr. R. K. Morton were subjected to a purification similar to that above. The material obtained had a melting point of 53°, and a mixed-melting point determination with material obtained from horse muscle showed no depression. The infra-red absorption spectrum of this material from calf intestine showed negligible differences when compared with that obtained from the horse-muscle ketone.

When the ketonic substance from muscle is fed or administered by stomach tube to rats receiving the casein-containing high fat diet, an increase in ketonuria lasting some days is consistently observed. It has not yet been possible to produce a response as great as that observed in animals receiving horse meat in place of casein; but methods of administration and dosage have not yet been completely explored.

It seems likely, therefore, that most of, if not all, the urinary ketone bodies excreted by rats receiving a high fat diet supplemented with meat protein result from the activity of a non-protein component of the meat. The earlier observations were made exclusively in diabetic patients or in animals rendered diabetic by experimental procedures. The present study, in which both alloxan-diabetic and normal rats have been used, indicates that this metabolic factor exerts its effect in normal as well as diabetic animals. The chemical nature of this substance and the means whereby it alters the metabolic pattern are under active investigation in this laboratory.

One of us (H. B. S.) would like to express his gratitude to the Merck Fellowship Board of the National Research Council of Canada, without the generous support of which this work would not have been possible.

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Sept. 2.

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[2] Marks, H. P., and Young, F. G., *J. Endocrinol.*, **1**, 470 (1939).
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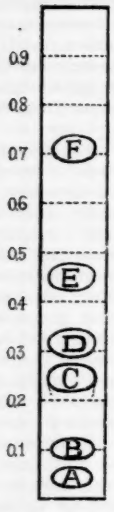
Relation of 3-Hydroxykynurenine to the Ehrlich Diazo Reaction of Urine in Severe Tuberculosis

It is well known that the urines of cases of severe tuberculosis often show the diazo reaction and the urochromogen test of Weiss. Recently, we have been trying to separate and to identify the substance responsible for these reactions. The results obtained are as follows. 700 ml. of urine obtained from a severe case of tuberculosis, which gave a strong diazo reaction and the urochromogen test of Weiss, was, after being saturated with ammonium sulphate and filtered, shaken vigorously with 140 ml. of 90 per cent phenol. After standing, the separated phenol layer (115 ml.) was shaken with a mixture of 115 ml. of ether with 55 ml. of water. After standing again, we took the separated water layer, which showed a brown colour, and washed it repeatedly with ether until the ether washing showed no more colour. The water extract was concentrated *in vacuo* to 15 ml., in which the greater part of the substance in question



Approximate R_F values of fluorescent spots obtained from urine of the severe tuberculous patient on paper chromatography in butanol–acetic acid

was collected. Further purification was performed by chromatographing on filter paper No. 50 of the Tōyō Filter Paper Company, Tokyo, using a system of *n*-butanol, acetic acid and water (4 : 1 : 5) as the developer, ascending method. The concentrate was developed as spots on filter paper strips or wider papers (40 cm. × 40 cm.) for 20 hr. Under ultra-violet illumination, six strongly fluorescent spots appeared (*A*, *B*, *C*, *D*, *E*, *F* in diagram).

Spot *C* represents 3-hydroxykynurenine; it gives an intense fluorescence, the ninhydrin reaction, a strong diazo reaction, and reduces permanganate solution. With the aldehyde reagent (a solution of *p*-dimethylaminobenzaldehyde in hydrochloric acid) it shows a red colour. Synthetic 3-hydroxykynurenine has the same R_F value (0·25) and the same colour tests with the reagents mentioned above.

In addition, the band showing this R_F on the developed filter paper was cut with scissors and extracted with water and the solution examined spectroscopically. Its ultra-violet absorption spectra ($\lambda_{1\,max.} = 270$, $\lambda_{2\,max.} = 370$ mμ) were identical in type with those of 3-hydroxykynurenine.

Spot *D* was identified as due to kynurenine by comparison of R_F by paper chromatography with the synthetic compound, with the ninhydrin reaction and the Otani–Honda test. It shows no Ehrlich diazo reaction or the urochromogen reaction of Weiss. Spot *E* is a mixture of kynurenic and xanthurenic acids, because the spot shows the same R_F value on the paper chromatograph as that of these two acids (in our technique these two acids cannot be separated from each other) and gives an intense green colour with ferric chloride solution, Kretschy's colour test, an orange colour with Ehrlich's aldehyde reagent and the urochromogen reaction, but does not show the ninhydrin reaction.

As in the case of B_6-deficient rats[1] fed supplementary tryptophane, it seems probable that the urine of our tuberculous patient might contain, in addition to kynurenine, 3-hydroxykynurenine, kynurenic and xanthurenic acids and conjugation products of these substances.

In fact, the presence of N$^{\alpha}$-acetyl-3-hydroxykynurenine and a conjugated product of xanthurenic acid might be postulated with high probability, though their amount seems to be small. Spot *F* corresponds to the former because its R_F resembles that of N$^{\alpha}$-acetyl-3-hydroxykynurenine, which was indicated in the literature[1], and gives the diazo reaction without giving the ninhydrin reaction. Spot *B* corresponds to the conjugate of xanthurenic acid[1], and shows a fainter diazo reaction.

Spot *A* coincides with 3-hydroxykynurenine *o*-glycuronide described by Dalgliesh *et al.*[1] from its ultra-violet absorption spectra ($\lambda_{max.} = 269$ mμ), the R_F on the paper chromatograph, by giving the ninhydrin test but no Ehrlich diazo reaction.

In conclusion, we can say that the major substance which is responsible for the diazo reaction of Ehrlich and the urochromogen test of Weiss is 3-hydroxykynurenine, an intermediate of tryptophane metabolism. Here it must be added that some time since, Dr. S. Oka in this laboratory was able to separate a 3-hydroxyanthranilic acid-like substance by paper chromatography (R_F 0·84, the same as that of pure 3-hydroxyanthranilic acid; positive diazo reaction) from the fraction which was obtained by precipitation with mercuric sulphate from the alcoholic extract of the diazo urine.

We are much indebted to Mr. S. Taga for technical assistance. We thank Prof. T. Sakan for gifts of synthetic 3-hydroxykynurenine and kynurenine, and Prof. Yashiro Kotake and Prof. Yahito Kotake for gifts of kynurenic and xanthurenic acids. To Dr. C. E. Dalgliesh *et al.* we are also indebted for pointing out the identification of the various spots described by them in *Nature*[1] and the relevant ultra-violet spectra.

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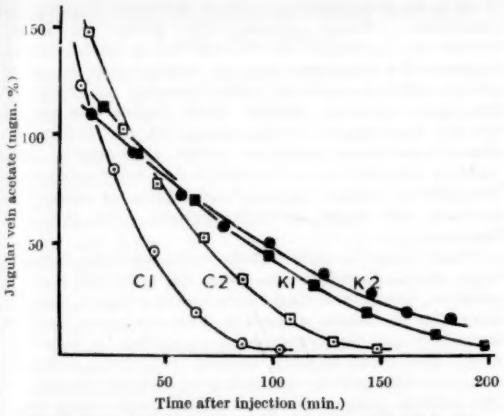
Acetate Metabolism in Ovine Ketosis

During the course of an investigation into ketosis in sheep, it was found that ketonæmia in the sheep is accompanied by a marked decrease in the rate at which injected acetate is metabolized.

The technique used was, in effect, an acetate-tolerance test: ewes for the control series were deprived of food for twenty hours before experiment, and then a standard dose of sodium acetate, equivalent to 500 mgm. acetic acid per kgm. body-weight, was injected into the jugular vein. The disappearance of acetate from the circulation and the appearance of ketone bodies were followed by taking samples of venous blood at intervals. Less than 5 per cent of the injected dose appeared in the urine in normal animals. Results have been obtained for sixteen normal ewes at different stages of pregnancy from 60 days to term, and for nine ewes, within two weeks of parturition, showing varying degrees of ketonæmia. The level of ketone bodies in the ketonæmic ewes varied from 9·3 mgm. to 25·5 mgm. per cent (measured and expressed as acetone per 100 ml. whole blood). The disappearance of acetate from the blood was slower in all the ketonæmic ewes than in the normal ewes. Four of the results have been plotted in the accompanying graph. The two curves, *C*1 and *C*2, show the fastest and slowest rates at which the injected acetate was metabolized in the group of sixteen control ewes. The other two curves, *K*1 and *K*2, were obtained from two cases of ketosis in ewes in which the level of ketone bodies were 15·4 mgm. and 17·5 mgm. per cent respectively.

In the ketonæmic animals studied, it was found that the higher the resting-level of ketone bodies, the more marked was the decrease in the rate of disappearance of acetate.



Disappearance of injected acetate. *C*1 and *C*2 give extreme findings in sixteen normal sheep during pregnancy. *K*1 and *K*2 are from two animals with ketosis in late pregnancy

Acetate has frequently been shown to be a precursor of ketone bodies. The injection into sheep of large amounts of acetate results in a small rise in the level of circulating ketone bodies[1]: in the control ewes of this series this was very reproducible both as regards magnitude and duration. In the ketonæmic animals, the acetate injection produced a different response, in that the rise in circulating ketone bodies was both delayed and smaller in amount to an extent which varied with the degree to which the metabolism of acetate was impaired. In these sheep the greater the degree of ketonæmia the less was the apparent conversion of exogenous acetate to ketone bodies.

There is a possible relationship between this derangement and the decreased rate of production of carbon dioxide from isotopically labelled acetate demonstrated *in vivo* in the fasting rat by Coniglio, Anderson and Robinson[2]. The significance of these findings in the sheep, in which the metabolism of absorbed acetate provides an important part of the energy requirements, and their possible relationship to the problem of ketosis, are the subjects of further investigation.

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Relation between Total and Exchangeable Sodium in the Body

Early workers, who studied the fate of sodium-24 administered to animals, showed that the isotope exchanged with the sodium of the tissues[1]. They assumed that all the body sodium participated in this exchange. That this assumption is incorrect was suggested by recent results obtained with dogs[2] and humans[3–5], in which 20–35 per cent of the body sodium was estimated to be non-exchangeable with plasma sodium-24.

In order to study directly the relationship between total sodium and exchangeable sodium, sodium-24 was injected intravenously into six adult, well-nourished rabbits. Blood samples were taken periodically and analysed for their radioactivity and sodium content. After varying times (6–96 hr.), the rabbits were killed and small samples of tissues were taken. The bodies were then minced. The tissue samples and portions of the well-mixed minces were dissolved in nitric acid and their radioactivity and sodium content determined[6].

The exchangeable sodium, obtained from analysis of blood samples, was $48 \pm 0{\cdot}75$ (s.e.) m.mol. sodium/kgm. body-weight, the value given by analysis of the minces being $46 \pm 1{\cdot}13$ m.mol. sodium/kgm. body-weight. These figures are not significantly different, and show that the usual clinical method of measuring exchangeable sodium, as the ratio of the total radioactivity in the patient to the specific activity of the plasma, gives valid results. The total sodium of the rabbits was $62 \pm 1{\cdot}5$ m.mol. sodium/kgm. body-weight, that is, the exchangeable sodium was $69 \pm 1{\cdot}7$ per cent of the total sodium. The non-exchangeable sodium of the rabbits therefore was $16 \pm 1{\cdot}9$ m.mol./kgm. body-weight.

Studies of the exchange of plasma sodium-24 with the sodium of bone in dogs[2] and humans[4,5] have shown that 55–70 per cent of the bone sodium is non-exchangeable. In rabbits[5] this figure is 61–68 per cent. Since the average sodium content of the rabbit bones was 270 m.mol./kgm. bone, the non-exchangeable sodium of bone was about 170 m.mol./kgm. bone; and, as direct measurements exclude the presence of any other major store of non-exchangeable sodium in the rabbit, this means that the bones constituted approximately 10 per cent of the total body-weight, a figure in good agreement with direct determinations[7].

These experiments therefore show that virtually all the non-exchangeable sodium of the rabbit is located in bone and is about 28 per cent of the total body-sodium.

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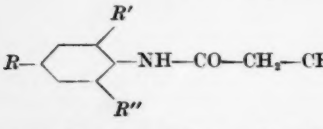
A New Type of Local Anæsthetic

Einhorn and Oppenheimer[1] more than fifty years ago synthesized a powerful local anæsthetic ('Nirvanin', the methyl ester of 3-diethylaminoacetylamino-6-hydroxybenzoic acid). Loefgren[2] prepared a similar compound ('Xylocain', 2-diethylaminoacetylamino-1-3-dimethylbenzene). Since this pioneer work in the field of local anæsthetics, many hundreds of effective compounds have been synthesized and tested; for a literature review on the subject, see Buechi, "Die Entwicklung der Arzneimittelforschung auf dem Gebiet der Lokalanaesthetica"[3].

A new series of compounds[4] of the type



where R = H or alkoxy, R' = H, CH_3 or alkoxy, R'' = H or CH_3, R''' = CH_3 or C_2H_5, has been prepared and shows marked local anæsthetic activity. One member of this series (R = OC_2H_5, R' and R'' = H, R''' = C_2H_5) was more active in guinea pigs than procaine and showed about half the toxicity in acute toxicity tests on mice. The other members prepared to date show approximately similar pharmacological properties to procaine, although their acute toxicity varies widely. Where R = H, R' and R'' = CH_3, R''' = C_2H_5 the toxicity in mice rises to about twenty times that of procaine.

Early attempts were made to synthesize the series from β-brombutyric anilide and dialkyl amines but resulted only in the formation of the anilide of crotonic acid. Treatment of this anilide, however, with excess amine under pressure gave the required substances in good yield.

Treatment of these β-dialkylaminobutyric anilides with concentrated hydrochloric acid yielded the corresponding aniline hydrochlorides and β-dialkylaminobutyric acid, thus establishing the position of addition of the amino group.

Full details of the chemistry and pharmacology of the series will be published elsewhere in due course.

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Sepsis and Cortisone

That cortisone is able to suppress the inflammatory reaction irrespective of the nature of the causative agent is now a generally accepted fact. The site at which it is able to exert this effect remains uncertain; but it has recently been shown that cortisone can prevent or nullify an increase in capillary permeability[1], and that its administration is associated with an increase of arteriolar tone[2]. The latter authors consider that these two vascular effects are the most significant factors in the modification of the inflammatory processes.

In order to ascertain whether the effects of cortisone in acute inflammation would be consistent with such a view, we have investigated its influence in pyogenic infection. Eight rabbits were given an intracutaneous injection of 0·1 ml. of a 24-hr. broth culture of a coagulase-positive staphylococcus. Five of the rabbits received intramuscular injections of 10 mgm. cortisone acetate daily during the period of the experiment (commencing 24 hr. before infection) and three animals served as controls. The rabbits were killed on the fourth day after infection; the affected area of skin and subcutaneous tissue was excised, and serial paraffin sections were cut and examined.

There was a marked difference between the appearance of the resulting lesions in the test and control animals, those receiving cortisone showing a sharply demarcated chancroid nodule, in contrast to the less circumscribed fluctuant lesion exhibited by the control. The most striking feature observed, however, was the absence in the cortisone-treated animal of the normal polymorphonuclear infiltration and associated tissue necrosis, which was replaced by a dense mononuclear infiltration with minimal tissue destruction. An additional finding of considerable significance was the complete absence of organisms in the lesions of the test rabbits, whereas all control animals showed their presence in large numbers.

Our findings suggest that the suppression of the inflammatory reaction enables the organisms to disseminate rapidly, as has been observed by Lewis[3] and Antopol[4]. This dispersion from a small focus might be responsible for the severe infections described by Seyle[5] and by Gledhill and Rees[6] in animals treated with cortisone.

Two possible explanations can be advanced for failure to localize the infection: either no inflammatory fibrin barrier is formed and the bacteria are carried away by lymphatic flow, as suggested by Seyle[5], or changes at the vessel wall arrest leucocytic diapedesis and so prevent phagocytosis. Both these factors are probably at work. The mononuclear infiltration, not being entirely dependent upon diapedesis, arises through proliferation or migration in the adjacent tissues.

The absence of necrosis in the cortisone-treated lesions may be attributed to the absence of polymorphonuclears and of exudate containing proteolytic enzymes.

All the above effects of cortisone are more readily and simply explained by an interference with the vascular phenomena of inflammation, as suggested by Ashton and Cook[2], than by postulating its intervention at some other stage. This view is supported by the observations of Moon and Tershakovec[7], who have shown that cortisone does not effect the margination of leucocytes in an inflammatory lesion.

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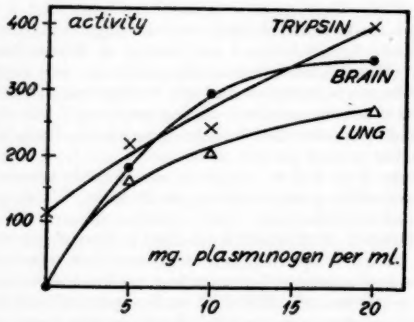
Fibrinolytic Activity of Tissue Extracts and of Trypsin

Macfarlane and Biggs[1] have reported on fibrinolytic enzymes in extracts of human tissues. The recent isolation of a soluble fibrinolytic activator from washed and dehydrated pig heart tissue[2] suggested a re-investigation of the fibrinolytic activity of such tissue extracts.

Saline extracts were prepared from the ground tissue from human lung and pig brain. The extracts were very active when estimated by the standard fibrin plate method[3], where the substrate (bovine fibrin) contains plasminogen. No fibrinolytic effect was observed when the extracts were tested on fibrin plates in which the plasminogen had been destroyed by heating as described by Lassen[4]. However, an effect was obtained when bovine plasminogen was added to the extracts, the size of this effect depending upon the amount of plasminogen applied (see graph).



Fibrinolytic effect of pig brain extract, human lung extract and crystalline trypsin on plasminogen-free fibrin when the concentration of bovine plasminogen in the active solutions is varied. Abscissa: Concentration of the plasminogen preparation in the sample. Ordinate: Activity recorded as the diameter product (in mm.^{2}) of the lysed zones

It is evident that the fibrinolytic agent contained in these extracts is an activator of plasminogen and not a fibrinolytic enzyme proper. It may be recalled that in extracts prepared from heavily disintegrated tissue (Potter homogenizer, Waring blendor) the fibrinolytic activity is caused by an activator present in the small particles[5].

In similar experiments the effect of plasminogen on the activity of a number of proteolytic enzymes was investigated. An increase in plasminogen concentration had only a slight effect on the activity of chymotrypsin (cryst., Armour), of an *Aspergillus* protease obtained from Dr. W. G. Crewther[6], of a proteinase from *B. subtilis* (obtained from Prof. K. Linderstrøm-Lang, Copenhagen) and of bovine plasmin (prepared by activation with fibrinokinase or spontaneously[7]). However, when trypsin (cryst., Armour) was added, an enormous increase in activity was produced when the concentration of plasminogen was increased (see graph).

Trypsin, therefore, in addition to its effect as a proteolytic enzyme, appears to act as an activator of plasminogen. Most probably this activation depends upon a partial proteolytic splitting of the plasminogen molecule. This action resembles the known effect of trypsin in blood clotting, by which prothrombin is converted into thrombin.

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Migration and Gregarious Æstivation in the Bogong Moth, *Agrotis infusa*

In 1834, Bennett[1] reported immense aggregations of the bogong moth, *Agrotis infusa* (Boisd.) (Noctuidæ, Lep.), in the clefts and small caves of granite outcrops on mountain-tops in southern New South Wales. There the aboriginal tribes congregated to feast upon these moths, which constituted a valuable fat-rich food. Scott[2] and others confirmed these observations, but no satisfactory explanation for the moth assemblages has been offered.

Aggregations of *A. infusa* have been studied during the past two summers at several sites, between 4,000 ft. and 6,000 ft., on the Brindabella Range in the Australian Capital Territory. Moths began to assemble on the mountain tops late in October and the populations reached a maximum before mid-December. In late November, a large unidirectional flight in a southerly direction was observed at a point four miles north of the chief observation site, Mt. Gingera (6,092 ft.). There was no major decline in populations before the end of March, when all the moths disappeared. In early April, another large unidirectional flight, this time in a northerly direction, was observed near Mt. Gingera.

Strongly gregarious behaviour was indicated by the layer of moths which covered, in a compact imbricated pattern, large irregular areas of the rock surfaces in the crevices and caves. For about one hour night and morning, just after sunset and before sunrise, a small proportion of the moths became intensely active and many indulged in a milling flight over the summit of the mountain, even when the outside air temperature was 7·0° C. At no time during these periods of activity was copulation or feeding observed. Dissections of a hundred female moths taken from the caves at weekly intervals throughout the summer showed that spermatophores were never present in the bursa copulatrix, where they are normally deposited during copulation. Without exception the ovaries were immature and the fat body well developed. Although sugary food was apparently not sought, water may have been ingested from rock surfaces moistened by rain or dew. In the laboratory, moths taken from the assemblages at Mt. Gingera neither copulated nor laid fertile eggs when fed water alone but did so when fed a sucrose solution. Some 10,000 moths, confined to a small cave on Mt. Gingera by means of wire gauze on January 10, behaved in a similar

manner to uncaged moths and did not attempt to escape until the end of March when the main moth populations had departed. Again, dissections of samples of the caged females taken at intervals showed that copulation had not taken place and the ovaries were undeveloped.

It seems clear that adults of the spring generation of *A. infusa* migrate in swarms to the mountains, where they æstivate gregariously. At the end of March the moths again migrate, presumably to their breeding grounds. Careful search has not revealed larvæ of this species in the vicinity of the adult æstivation sites although suitable food plants are abundant. The larvæ have, however, been recorded as pests of field crops and pastures over a wide area of the tablelands and western slopes of New South Wales, and in other southern States.

Although migration is now known to occur in many Lepidoptera, *A. infusa* is believed to be the first species in which gregarious æstivation following spring migration has been reported. The monarch butterfly (*Danaus plexippus* (L.)) of North America migrates south during the autumn to hibernate gregariously in southern California and in Florida, migrating north again in the spring[3]. Pepper[4] suggested that the sudden disappearance of the noctuid, *Chorizagrotis auxilaris* Grote, from Montana and Alberta with the approach of summer may be due to migration to higher elevations where æstivation may be possible at lower temperatures. In Egypt and India, *Agrotis ypsilon* (Rott.) is believed to migrate northwards to the mountains for the summer months[5], but there have been no reports of æstivation.

Detailed results of these studies will be reported elsewhere.

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Observations on the Newly Born Leopard Seal

Part of the biological research of the Australian National Antarctic Research Expedition at Heard Island during 1951 was aimed at solving the unknown factors about the leopard seal, *Hydrurga leoptonyx* (De Blainville). The rate of fœtal growth for the complete gestation period was investigated and specimens were obtained from February onwards. No newly born pup had previously been seen, because the pregnant females migrate during September–October to the southern pack-ice where the pup is born. To overcome this difficulty, the men at Heard Island constructed a large mobile cage and drove a pregnant female leopard seal into it on September 12, 1951. Every three or four days the cage was dragged into the sea at low tide and left for the rest of the day. The seal would not feed during captivity, but it was noticed that she drank large quantities of sea water on being placed in the ocean.

(*A.N.A.R.E. Photo*)

Leopard seal fœtuses aged 2½, 3, 5 and 7 months respectively

Some days before pupping, the female assumed a characteristic position, lying on its side. Uterine and vaginal contractions were easily discernible and movements of the fœtus reached a maximum as the date of birth approached. Contractions were sometimes accompanied by moaning noises and considerable restlessness. Whether or not parturition was a rapid process is unknown since, in this case, birth occurred unseen between 9 p.m. and 6.45 a.m. on November 14.

From the position of the mother, pup and placenta, it is assumed that the pup was born head first in a manner similar to the sea elephant and the other three Phocids. The umbilical cord attached to the placenta was probably broken by the pup in its movements and remained as a stub about 4 in. in length. The newly born pup was 62 in. in length and weighed 65 lb.

Measurements were :

Flipper length (inside)	16 in.	Girth before tail	19 in.
Tail flipper length (inside)	16 „	Neck circumference	17 „
Girth behind flippers	24 „	Width at flippers (ventral)	12 „

The eyes were open at birth and the adult dentition was well developed, the tips of the canines and one incisor being visible externally. The placenta showed no special peculiarities and weighed 6 lb.

The behaviour of the parent to the pup after birth must be regarded conservatively in this case, since the pup was dead during its observation. Two facts are apparent, however : first, the mother was affectionate towards the pup and indignant at intrusion ; and secondly, she displayed a definite desire to keep the pup warm. This latter point was most noticeable, the mother lying alongside the pup and keeping the closest possible contact with it.

The birth of the sea leopard pup would appear to follow the pattern of parturition in other types of seals. The advanced developmental stage of the adult dentition indicated that the period of lactation would be very short, probably from ten to fourteen days. If the rate of growth followed the trends of other

Phocids, the pup would have a weight of about 125 lb. at weaning.

Apart from rate of fœtal growth, many other investigations were carried out. The milk dentition, which it reabsorbed before birth, was ascertained by taking X-rays of fœtuses. More than a hundred animals were branded and their movements studied for migration, etc. All the information is now being prepared for a comprehensive paper on the biology of the leopard seal.

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Terramycin in the Treatment of Experimental Rabies in Mice

The following experiment was carried out to test the value of terramycin[1] in the treatment of experimental rabies in mice.

The strain of rabies virus used in this experiment was Paris fixed strain. It was obtained in 1935 from the Public Health Laboratories in Jerusalem. Since that time it has been maintained in rabbits and sheep and used in these laboratories for the routine preparation of antirabic vaccine. It never failed to produce paralytic rabies in sheep, rabbits and mice in 6–7 days. Its potency is such that the L.D.50 for mice, calculated by the method of Reed and Muench, is $0{\cdot}03$ ml. $\times 10^{-6}$ brain emulsion[2].

The mice used were albino Swiss mice which were originally obtained from Dr. Mahaffy, of the Virus Reference Laboratory, Entebbe, and bred locally in Khartoum for the past twelve years. The average age of the mice used in this experiment was three weeks. Each mouse was weighed and the dose of terramycin required was calculated. Each mouse received 150 mgm. of terramycin per kgm. body-weight twice daily with an interval of four hours between the two doses.

Crystalline terramycin hydrochloride in capsules manufactured by Chas. Pfizer and Co., Inc., was used. The contents of one capsule (250 mgm.) were put in a 100-ml. conical flask and 25 ml. of McIlvaine's phosphate–citric acid buffer solution, *p*H 7·0, added. The flask was then shaken thoroughly until a fine emulsion was obtained. A fresh preparation was made daily and kept at 4° C. in the refrigerator until required.

Three groups of mice each consisting of ten mice were used. Each mouse was lightly anæsthetized with ether and then injected intracerebrally with 0·03 ml. of 1 per cent brain material emulsified in normal saline. Group 1 was left without further interference to serve as controls. Group 2 was treated with intramuscular injections (150 mgm. per kgm. body-weight) of terramycin twice daily. Treatment was started half an hour after the intracerebral injection, repeated four hours later and continued twice daily for six days. Group 3 was similarly treated with terramycin for six days, but the intraperitoneal route was used in this group.

On the sixth day of injection, all the thirty mice in the three groups developed paralysis, which started in the hind legs and then became generalized. The mice died of typical paralytic rabies on the sixth or seventh day. No difference whatsoever was noted between the mice treated with terramycin and the untreated control mice, either in the incubation period or in any other feature of the disease. Hence we conclude that terramycin has no value in the treatment of experimental rabies in mice.

M. A. Haseeb

Stack Medical Research Laboratories,
Khartoum, Sudan.
June 4.

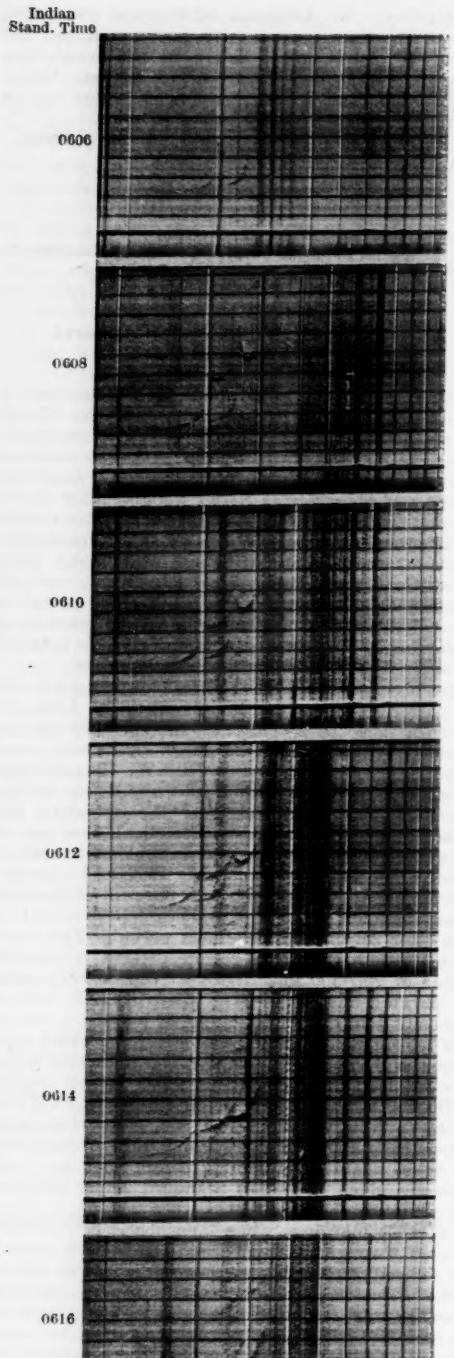
[1] Finlay, A. C., *et al.*, *Science*, **111**, 85 (1950).
[2] Kirk, R., Haseeb, M. A., and Davis, A. T., *Trop. Med. and Hyg.*, **73**, 167 (1950).

A New Early-Morning Ionospheric Phenomenon

Early in January 1952, when ionospheric observations were started at Kodaikanal (10° 14′ N., 77° 28′ E.), an interesting phenomenon, which, to my knowledge, has not hitherto been reported, was observed in the vertical-incidence virtual height/critical frequency records. It was found that on most of the mornings ionospheric echoes ceased to return some minutes to several hours before sunrise and reappeared at about ground sunrise time. Systematic daily observations were started early in March and *h′f* records taken at short intervals beginning about an hour before sunrise daily with the view of examining the frequency of occurrence and any possible seasonal characteristics of this 'no echo' phenomenon.

The observations consisted in photographing the *h′f* patterns at 1- or 2-min. intervals with the *C.R.P.L.* type *C*-3 recorder of the Kodaikanal Observatory covering 1–25 Mc./s. and with peak pulse power of approximately 10 kW. The antenna system consisted of two multiple-wire deltas having reasonably flat impedance over the operating frequency-range and the desired vertical direction of maximum radiation. The records thus made cover a period of five months (March–July 1952) and on examination indicate that on about 60 per cent of the days during these five months ionospheric echoes ceased for some time during the pre-dawn period. The overnight stratum in the *F*-region present at virtual heights of 200–300 km. disappeared gradually without showing any appreciable sharp drop in critical frequency (which is of the order of 1–3 Mc./s. during early mornings). The 'no echo' condition lasted until about the ground sunrise time, when reflexions began to be received from markedly greater virtual heights of 300–500 km. Records taken at 15-min. intervals on the morning of April 30, 1952, show that pulse returns ceased between 0500 and 0515 hr. and did not begin again until shortly before 0545 hr. (All times are given in Indian Standard Time, which is 5 hr. 30 min. ahead of G.M.T.)

On other mornings when ionospheric echoes were received throughout, high-speed ionospheric soundings showed remarkably characteristic sunrise effects in the *F*-region. Almost simultaneously with the ground sunrise, a stratum formed somewhere between 300 and 600 km. The virtual height of the new stratum decreased rapidly until it merged with the overnight layer, usually present at a virtual height of about 200–250 km. The accompanying photographs are of a sequence of *h′f* records obtained on one such morning; they were taken at 2-min. intervals on March 9, 1952, and illustrate the characteristic sunrise effect observed at this location.



A study of sunrise effects in the ionosphere has been made by Wells[1] at Derwood Experimental Laboratory, D.T.M., Carnegie Institution of Washington. Sunrise effects have been defined as the initial characteristic rise of ion density in the neighbourhood of sunrise. At Kodaikanal, the abrupt appearance of echoes from relatively great virtual heights, such as shown in the records for March 9, 1952, has enabled the determination of the precise times of these effects. A study of successive $h'f$ records at 1- or 2-min. intervals on selected days when such records were available indicates that, notwithstanding a certain amount of scatter, the sunrise effect and the ground sunrise were simultaneous during the month of March; during April, the ionospheric effect occurred 2 min. after the ground sunrise, and during May, June and July it occurred $3\frac{1}{2}$ min., 6 min. and 5 min. respectively before the ground sunrise.

I wish to thank Dr. A. K. Das, director of the Kodaikanal Observatory, for his advice in writing this note.

B. N. Bhargava

Kodaikanal Observatory,
India. Aug. 15.

[1] Wells, H. W., *J. Geophys. Res.*, **54**, 277 (1949).

Automatic Particle-Sizing by Successive Countings

Walton[1] has recently summarized informal discussions among workers in Great Britain on methods for the automatic counting and sizing of particles dispersed on microscope slides. The field is normally scanned with a beam of light, and the changes in transmission or reflexion as the scanning beam (for example, a slit or a spot) encounters particles, or parts of particles, are detected photoelectrically. The quantities that can be measured are the pulse-heights (related to the areas of the particles), the pulse-lengths (related to the lengths of particles) and the number of pulses. Methods of counting have been based on measurements of the number of pulses occurring in the area swept by the scanning aperture; but all proposals for sizing have been based on the measurement of pulse-heights or pulse-lengths. It is the purpose of this communication to point out that sizing also can be carried out by recording only the number of pulses. The relatively simple instruments designed for counting can therefore be employed for sizing.

It is obvious that if the geometry of the scanning aperture or the response-level of the detecting device can be arranged so that the number of pulses recorded is dependent on the size of the particles, then the size distribution can be obtained by repeated counting with different scanning apertures or response-levels. For example, if the field is scanned with a slit and a count is recorded only when the slit is totally obscured, the number of pulses recorded is clearly dependent on the size of the slit relative to the size of the particles; there will be no count for a very large slit, whereas every particle in the scanning track will produce a recorded pulse with a sufficiently small slit. In the general case, the scanning aperture may have any shape and any orientation relative to the direction of scan or may consist of several apertures such as a pair of scanning spots. In addition, the response-level of the detecting device may be set to any finite value.

In one of the simplest applications, the field is scanned, not necessarily systematically, with a slit of width w (perpendicular to the direction of scan) which is varied in repeated scans from w less than a, the size of the smallest particle present, to w greater than b, the size of the largest particle. The number of times, $m(w)$, the slit is totally obscured in unit length of scan is recorded for each of several scanning track widths, w. If the number of particles (of all sizes) per unit area of the field is N, it can be shown that the size distribution is given by $1/N$ times the second derivative of the observed frequency distribution $m(w)$.

An alternative method, especially suitable for use with the 'flying-spot' microscope[2], is to scan the field with two spots (each smaller than the smallest particle present), the distance apart of which, w, is similarly varied over the range a–b in repeated scans of the field. The frequency $m(w)$ is the number of times per unit length of scan that both spots are simultaneously obscured. It is not necessary, however, to provide separate detecting devices for the two spots or coincidence circuits for recording simultaneous pulses. It can be shown that $m(w)$ is equal to the difference between *twice* the number of pulses observed with a *single* spot (in a separate scan) and the number of times that two spots encounter particles simultaneously or separately. The latter number is measured by a single detecting device behind the two spots, so that simultaneous interceptions produce only single pulses.

The theoretical treatment, although simple, can only be outlined here. A slit describing a scanning track of width w across a field of particles intercepts, in unit length of track: m_1 whole particles of size d less than w; $2m_2$ part particles of any size overlapping one or other edge of track; and m_3 part particles of size d greater than w lying right across the track. Since the number, $m_2 + m_3$, of particles lying on either edge of the track is, on the average, equal to the number per unit length occurring in a strip of width given by the average particle size $\overline{d}$, the effective width of the scanning track is $w + \overline{d}$. We have also that $m_2 + m_3 = N\overline{d}$. Thus, the number per unit area is $N = (m_1 + 2m_2 + m_3)/(w + \overline{d})$, and hence:

$$\overline{d} = (m_2 + m_3)/N \text{ and } N = (m_1 + m_2)/w.$$

These relations, being independent of the particle-size relative to the slit-width, are applicable to particles of any given size d when N and m refer to the numbers of that size. The relation above between $m(w)$ $(= m_3(w))$ and the size distribution follows readily. There are corresponding relations for $m_1(w)$ and $m_2(w)$. The significance of the 'size' measured cannot be discussed here, but it may be noted that the average size $\overline{d}$ is the average Feret diameter, which Walton[4] has shown, for particle-shapes having no re-entrant angles, to be equal to the perimeter diameter (the diameter of a circle having the same perimeter as the particle).

The number of particles per unit area, N, and also the average size $\overline{d}$, can be found by several methods. For example, with a slit of width w, the number of pulses per unit length is $m_1(w) + 2m_2(w) + m_3(w) = N\overline{d} + Nw$; and N and $\overline{d}$ may be deduced from measurements with two slit-sizes or with a slit and a guard spot. The slits may be of any size and need not be larger than b, as Wolff[3] implies. Again, with two spots at a spacing w less than a, the number of pulses is $2m_2(w) + m_3(w)$; while the number of pulses for a single spot is $m_2(w) + m_3(w)$; the difference $m_2(w)$ is equal to Nw, since $m_1 = 0$ when w is less than a. This method is more general, and experimentally simpler, than the double-spot counting procedure described by Roberts and Young[5], which requires systematic scanning with two 'labelled' spots having separate detecting devices.

Experimental investigations are in progress, and a full account will be published elsewhere.

P. G. W. Hawksley
British Coal Utilization Research Association,
Randalls Road,
Leatherhead, Surrey.
Sept. 1.

[1] Walton, W. H., *Nature*, **169**, 518 (1952).
[2] Young, J. Z., and Roberts, F., *Nature*, **167**, 231 (1951).
[3] Wolff, H. S., *Nature*, **165**, 967 (1950).
[4] Walton, W. H., *Nature*, **162**, 329 (1948).
[5] Roberts, F., and Young, J. Z., *Nature*, **169**, 932 (1952).

Four-strand Crossing-over

T. C. Carter and A. Robertson, in a recent publication[1], have discussed a model of genetical interference in diploids, introducing explicitly postulated components of chiasma and chromatid interference. It appears, however, that their work is accompanied by certain misconceptions and erroneous pronouncements.

Carter and Robertson object to my view[2,3] that in many situations it is unnecessary to consider explicitly the detailed interaction of the four strands of a meiotic bivalent in bringing about genetical recombination. Such situations are those in which the observed frequencies are determined only by the probability distribution of exchange points on a single strand. The great majority of genetical studies on diploids do, in fact, relate to such situations, and it is much more rarely that an organism provides evidence concerning the simultaneous distribution of the exchange points on two, three or four strands of the same bivalent. Consequently, attempts to set up *detailed* models of four-strand interaction will, in the majority of cases, necessarily require an abundance of *ad hoc* hypotheses which are incapable of verification from genetical data, and therefore impose artificial restrictions on theory, entailing an undesirable lack of generality.

With these considerations in mind, I asserted that in such cases (admitting only of the examination of single strands) it is sufficient in formulating a mathematical description to confine attention to the probability distribution of exchange points upon any single one of the four strands produced in meiosis. This view, which seems to me to express merely an exceedingly simple and obvious logical proposition, is regarded by Carter and Robertson as "unsupportable". They say that in my treatment I was tacitly employing a two-strand model, and was, moreover, describing the distribution not of exchange points but of chiasmata. There is, however, no foundation for these statements.

Since the major difficulty experienced by Carter and Robertson is a logical one, I would like to put forward a simple analogy. Suppose that a quality control inspector has to check the dimensions of aluminium rods. I, together with most people,

would say that all he requires is a single specification applicable to any rod produced by the manufacturing process. Carter and Robertson would seem to insist that he be provided with a specification descriptive of batches of rods as produced simultaneously by the machines.

In my own treatment[2-4] I did, in fact, deal with four-strand recombination and *not* two-strand. I dealt with exchange points and not with chiasmata as Carter and Robertson assert. Further, I have given various formulæ which in my papers[2,3] are labelled explicitly as referring to exchange points. These have been quoted by Carter and Robertson (out of context) as referring to chiasmata. As I shall show, this course, which seems to have been adopted as a result of a primary misconception, is likely to lead to error.

My treatment was first developed in terms of an unspecialized interference function $f(t)$, relating to exchange point intercepts, which can be specialized in ways considered most likely to fit experimental data. At the next stage in the argument I selected a special form, $4te^{-2t}$, which remarkably unites two advantages. First, it is mathematically very convenient, and secondly has been found to accord well with empirical evidence[2-5]. Now it so happens that the *general* theory (prior to specialization) is formally applicable to chiasmata as well as to exchange points. But at the stage where specialization of $f(t)$ becomes necessary, I deliberately chose the form $4te^{-2t}$ as descriptive of exchange points and *not* of chiasmata. At a critical stage in the construction of their own model, Carter and Robertson find need to insert in their formula some theoretical chiasma statistics, and 'solve' this problem by taking over formulæ of mine (based on the function $4te^{-2t}$) which, in fact, were chosen by me as appropriate to exchange point statistics. No critical examination is made of the suitability of these formulæ with regard to empirical justification when applied to chiasmata. To say the least, this slip seems likely to impair the value of the mathematical structure they have erected.

I might add, in conclusion, that at the time my paper was published, I had investigated the compatibility of the function $4te^{-2t}$ with the mechanism of four-strand exchanges, and confirmed that it was consistent with a variety of models involving different intensities of chromatid and chiasma interference[5].

A. R. G. Owen

Department of Genetics,
Cambridge.

[1] Carter, T. C., and Robertson, A., *Proc. Roy. Soc.*, B, **139**, 410 (1952).
[2] Owen, A. R. G., *Proc. Roy. Soc.*, B, **136**, 67 (1949).
[3] Owen, A. R. G., "Advances in Genetics", **3**, 117 (1950).
[4] Owen, A. R. G., *Nature*, **168**, 208 (1951).
[5] Owen, A. R. G., Ph.D. dissertation, University Library, Cambridge (1948).

Dr. A. R. G. Owen has developed the mathematical treatment of linear sequential events. He applied it to the occurrence of exchange points in a gamete, that is, those chiasmata at the preceding meiosis in which the strand entering the gamete took part: chiasmata involving only other strands were not considered. To describe this as a four-strand model is true only in so far as three emergent strands are disregarded; it can equally well be described as a model with two, three or any number of strands. The resulting equations are formally identical with those of a two-strand model; for this reason chromatid interference, which is a multi-strand phenomenon and of which there is sound cytological evidence[1], cannot be distinguished from chiasma interference.

This model seemed to us biologically unsatisfactory; we therefore applied Owen's treatment of sequential events to chiasma formation in a four-strand model, which allowed an explicit treatment of chromatid as well as chiasma interference.

T. C. Carter
Alan Robertson

Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.

[1] Huskins, C. L., and Newcombe, H. W., *Genetics*, **26**, 101 (1941).

Computing Machine Terminology

In a recent letter in *Nature*[1], Prof. R. O. Kapp raises a protest against the use of certain expressions current in the vocabulary of computing machine designers. The chief burden of Prof. Kapp's remarks is directed against the use of anthropomorphic terms, and it is perhaps of interest to see how these arose. The earliest idea for an all-purpose computing machine, in the modern sense, was due to Charles Babbage[2], who used the terms: mill = portion of machine which operates on numbers; store = portion of machine which holds numbers and emits or absorbs them at the direction of the machine.

When the actual construction of an electronic calculator was first considered, by von Neumann and his group, the logical design was made to depend, to a considerable extent, on what were, at that time, conceived to be the neurological mechanisms of animals. This led to the development of a nomenclature which had the characteristics deprecated by Prof. Kapp.

In fact, most designers (as distinct from the "enthusiasts" of Prof. Kapp) now favour a more down-to-earth vocabulary in which, for example, 'memory' is replaced by the less exceptionable word 'store'. On the other hand, Prof. Kapp is not correct in stating that the words 'setting' and 'adjustment' are synonymous with the 'instruction' and 'teaching' of computer parlance. Neither does the word 'readings' have much relationship to the 'information' given to a computer.

So far as Prof. Kapp's 'code' is concerned, this word is very widely used in computer technology, and the equivalent 'machine language' has been added by linguists and semanticists who have recently 'discovered' these machines.

It has not been possible, in a short note, to consider in detail the technical meaning of the words given above; but it is worth pointing out, in conclusion, that the word 'decision'—or as we prefer it, 'conditional transfer of control'—does not necessarily imply that the machine follows a pre-determined sequence of events. On the contrary, the conditional transfer is frequently used in order that the machine should select between alternative courses of action in a manner which may never become known to the human operator.

Andrew D. Booth

Birkbeck College Computation Laboratory,
London, W.C.1.
Oct. 16.

[1] Kapp, R. O., *Nature*, **170**, 547 (1952).
[2] Babbage, H. P., "Babbage's Calculating Engines" (Spon and Co., London, 1889).

FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Saturday, December 6

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—General Meeting.

Monday, December 8

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. G. Bradfield: "Measurement of Elastic Constants of Solids".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. Schrödinger, For.Mem.R.S., and Prof. Max Born, F.R.S.: Discussion of Prof. Schrödinger's paper "Are there Quantum Jumps?"

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. W. B. Fagg: "The Nature of African Art".•

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the YORKSHIRE SECTION of the S.C.I., and the SHEFFIELD METALLURGICAL ASSOCIATION, at the Grand Hotel, Leopold Street, Sheffield), at 6.45 p.m.—Dr. U. R. Evans, F.R.S.: "The Corrosion Resistance of Stainless Steels".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. G. W. Murray: "Land of Sinai".

Tuesday, December 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. A. H. Smith: "English Place-Names".•

CHADWICK PUBLIC LECTURE (at the Wright-Fleming Institute, St. Mary's Hospital Medical School, Norfolk Place, London, W.2), at 4.30 p.m.—Dr. A. I. G. MacLaughlin: "The Prevention of Dust Diseases of the Lungs" (Malcolm Morris Memorial Lecture).•

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. E. Merritt: "The Place of Research in the Engineering Process with particular reference to the Automobile Industry".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. N. C. H. Humphreys: "Matching Rubber Compounds"; at 7 p.m.—Mr. G. F. Morton and Mr. P. Hatfield: "Recent Applications of Physics to Inspection Methods in the Rubber Industry".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. C. Weston: "Visual Fatigue".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Bulk Polymerization".•

Wednesday, December 10

ROYAL SOCIETY OF MEDICINE, PATHOLOGY AND MEDICINE SECTIONS (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Discussion on "Chemotherapy of Tuberculosis".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Liquefied Petroleum Gases" (Mr. E. Squire: "Production"; Mr. S. Shaw: "Distribution"; Mr. T. H. Taylor: "Applications").•

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-EASTERN SECTION (at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. G. D. Clifford: "The Development of the Radio and Electronics Industry in India".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The B.B.C. School, Evesham" and "The Post Office School, Stone" (to be opened by Dr. K. R. Sturley and Mr. H. R. Harbottle).

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Discussion on "The Problem of Future World Food Supply". (Speakers: Mr. F. Le Gros Clark and Dr. E. W. Russell.)

Thursday, December 11

BRITISH SOCIETY OF RHEOLOGY (at the Institute of Physics, Belgrave Square, London, S.W.1), at 2 p.m.—Symposium on "The Rheology of Foodstuffs".

PHYSICAL SOCIETY. OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. W. Merrison and Mr. E. R. Wiblin: "The Total Neutron Cross-section of Cobalt, Silver, Iodine, Aluminium, Nickel and Gallium between 1 eV. and 5 keV."; Mr. J. Dyson: "An Interferometer Microscope for Opaque Objects".

ROYAL METEOROLOGICAL SOCIETY (in the Beveridge Hall, University of London, Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Dr. G. M. B. Dobson, F.R.S.: "The Upper Atmosphere". (Meeting is open to Sixth Form students.)

Friday, December 12

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the APPLIED MECHANICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. Nicol Gross: "Experiments on Short-radius Pipe-bends".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Hayne Constant, F.R.S.: "The Application of Research to the Gas Turbine" (David Laing Lecture).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Mr. E. L. Streatfield: "Ion Exchange and its Application in the Fine Chemicals Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. W. H. Pearsall, F.R.S.: "Habitat, Vegetation and Man".

Friday, December 12—Saturday, December 13

UNIVERSITIES OF GREAT BRITAIN AND NORTHERN IRELAND (in the William Beveridge Hall, University of London, Senate House, Malet Street, London, W.C.1).—Conference.

Friday, December 12

At 2.30 p.m.—"Halls of Residence and Student Amenities".

Saturday, December 13

At 10.30 a.m.—"Success and Failure at the University"; at 2.30 p.m.—"Vacation Employment".

Saturday, December 13

BRITISH PSYCHOLOGICAL SOCIETY (in the Anatomy Theatre, University College, London, W.C.1), at 2.30 p.m.—Mr. Philip L. Short: "Some E.E.G. Findings in relation to Psychological Factors".

BRITISH ASSOCIATION OF CHEMISTS (at the Waldorf Hotel, Aldwych, London, W.C.2), at 3 p.m.—Thirty-fifth Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BACTERIOLOGIST (honours graduate, preferably with research experience) to work on problems of hygiene in the dairy industry—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/15 (December 13).

LECTURER IN CHEMISTRY at the Technical College, Coatbridge—The Director of Education and Deputy County Clerk, Lanarkshire House, 191 Ingram Street, Glasgow, C.1 (December 13).

SCIENTIFIC OFFICER (with an honours degree in biochemistry or physiology) IN THE NUTRITION DEPARTMENT, to take part in work that will include the determination of the biological value of proteins, the study of calcium and phosphorus metabolism using radioactive tracers, vitamin D assays and general nutritional experiments with rats—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/14 (December 13).

SUPERVISING GEOPHYSICIST to be responsible for the supervision and direction of all field, laboratory and office operations regarding geophysical prospecting for radioactive minerals, a SENIOR GEOPHYSICIST to take charge, under direction, of field, laboratory and office investigations of a group engaged in air-borne scintillometer survey, a GEOPHYSICIST (Grade 3) to take charge, under direction, of a party engaged in the field and/or laboratory on radio-metric investigations in connexion with the search for deposits of radioactive minerals, a GEOPHYSICIST (Grade 2) to carry out, under direction, field, laboratory and office investigations concerning deposits of radioactive minerals; a SUPERVISING GEOLOGIST to be responsible for the supervision and direction of field operations of the radioactive group of the metalliferous deposits sub-section, a GEOLOGIST (Grade 3) to carry out, under direction, the more advanced types of petrological and mineralographic investigations and compile reports thereon, or to take charge, under direction, of a party engaged in the geological mapping of deposits of radioactive minerals, a GEOLOGIST (Grade 2) to carry out in the field, under direction, mapping of deposits of radioactive minerals, and assist in the preparation of reports; in the Bureau of Mineral Resources, Geology and Geophysics, Australia—The Deputy High Commissioner, Australia House, Strand, London, W.C.2, endorsed 'for attention of The Senior Representative, Division of Industrial Development' and stating position applied for (December 20).

FELLOWSHIP IN PURE OR APPLIED MATHEMATICS—The Registrar, Trinity College, Dublin (December 31).

SENIOR LECTURER OR LECTURER IN PHYSICS at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (January 1).

STATISTICIAN IN THE DEPARTMENT OF AGRICULTURE AND HORTICULTURE at Long Ashton Research Station—The Registrar and Secretary, The University, Bristol 8 (January 3).

LECTURER IN PHYSICAL CHEMISTRY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 17).

BIOCHEMIST at the South Devon and East Cornwall Hospital, Greenbank Road, Plymouth—The Group Secretary, Plymouth, South Devon and East Cornwall General Hospital Group, 7 Nelson Gardens, Stoke, Plymouth.

CHEMIST (Senior Scientific Assistant) at the Central Laboratory, Chiswick, with responsibility for section dealing with paints and surface protection—The Staff Officer (F./EV.223), London Transport, 55 Broadway, London, S.W.1.

CHEMISTS at Ministry of Supply research establishments in Southern England for (*a*) work in laboratory providing chemical services, including effluents testing, process control, and boiler-water treatment (industrial experience desirable), (*b*) inorganic analysis (experience of radiochemistry desirable), (*c*) general chemical work (some experience of paint technology of advantage), and (*d*) physical chemistry research —The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E.735/52A.

ELECTRICAL ENGINEER for the Central Electrification Scheme, Cyprus—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.29024.B.

PLANT PATHOLOGIST (with honours degree in botany and at least two years' postgraduate experience), Nyasaland, for advisory and investigational work, mainly at Lilongwe Research Station—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.63/4/01.

PRINCIPAL—The Clerk to the Governors, Loughborough College of Technology, Loughborough.

SCIENTIFIC OFFICERS (with first- or second-class honours degree, or equivalent, in physics, engineering or mathematics) for operational research on a wide variety of problems in London and provinces, under direction of Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.285/52A.

SILVICULTURAL ECOLOGIST (with good honours degree with two years' postgraduate experience which must include work on soils) in Malaya, for research in the reclamation of degraded soils and waste-land, to restore fertility and productivity, possibly by introduction of suitable forest cover—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.87/60/01.

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